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WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEX--ETC(U)
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(6) # WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEXAS. VOLUME I. Basin Plan.

Prepared by

THE GOVERNOR'S PLANNING COMMITTEE

Office of the Governor
Texas Water Development Board
Texas Water Quality Board
Texas Water Rights Commission
Texas Parks and Wildlife Department
Railroad Commission of Texas
Texas State Department of Health
Texas State Soil and Water Conservation Board
U. S. Department of the Interior
U. S. Department of Housing and Urban Development
U. S. Environmental Protection Agency
Farmers Home Administration
Lower Colorado River Authority
Colorado River Municipal Water District
Central Colorado River Authority
Upper Colorado River Authority
Capital Area Planning Council
Alamo Area Council of Governments
Central Texas Council of Governments
Concho Valley Council of Governments
Houston-Galveston Area Council
Permian Basin Regional Planning Commission
South Plains Association of Governments
West Central Texas Council of Governments
Nine General Public Members

Honorary Members

Congressman J. J. Pickle
Congressman John Young
Congressman Omar Burleson
Congressman O. C. Fisher

Study Management By

U. S. ARMY CORPS OF ENGINEERS, FORT WORTH DISTRICT

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(11) Sep[redacted]73

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I. SUMMARY

Objective.

The objective of the Colorado River Basin Wastewater Management Study is the development of the most cost-effective strategy to meet stream water quality criteria for the 50-year planning period, 1970 to 2020. The Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500 (hereinafter referred to as PL 92-500) set national goals and policy with respect to levels of wastewater treatment and discharge of pollutants. The alternatives considered in the Study include strategies and projects to approach no discharge of pollutant by 1985. Section 101 of the Public Law seeks to restore the chemical, physical and biological balance of waters by eliminating pollutant inflow into waters by 1985 and to insure water quality for public use and the protection of aquatic life.

Planning Authority.

The Governor of Texas appointed the Governor's Planning Committee to provide overall planning direction and to assure that the Colorado River Basin Wastewater Management Study reflected the views of the State of Texas and of a broad cross-section of its constituents. Authority for the U.S. Army Corps of Engineers, Fort Worth District, participation was provided under the resolution of the U.S. House of Representatives Committee on Public Works adopted July 29, 1971 which read as follows:

> "Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports on Colorado River and its tributaries, Texas, submitted in House Document No. 361, Seventy-First Congress, Second Session, with a view to determining the feasibility of regional water supply and wastewater management facilities including measures for water quality control, wastewater collection, purification, and/or reuse."

Scope of Investigation.

The scope of this study covered the existing and projected conditions in the 39,900-square-mile Colorado River Basin, Texas by the following considerations:

- Definition of the study area with physical, institutional, and socio-economic descriptions.
- Present and projected water resources and usage.
- Existing water quality, established standards, and problems encountered in achieving the desired quality.
- Present and projected wastewater sources, including point and non-point sources.
- Waste load allocations and segmentation of the Basin waters to meet water quality standards and define the stream's assimilative capacity.
- Presentation of possible Basin alternatives for achieving water quality.

Planning Committee and Coordination Efforts.

The Governor's Planning Committee was created to provide overall planning direction and to assure that the study reflects the view of a broad cross-section of the general public. In the make-up of the Committee, the Governor of Texas appointed officials in various Federal, State, regional, and local governmental units, as well as local representatives from the general public. The four U.S. Congressmen within the Basin area were also members of the Committee. In the selection of Committee membership, care was taken to obtain representation from all geographic regions of the Basin, thereby creating an avenue for ready means of communications between the study management and the local interests. Members of the general public on the Committee were selected to include representatives of the conservation and environmental interests, as well as labor, management, agricultural, and industrial groups.

In the assignment of tasks to be accomplished by non-Federal entities in the process of the study, the Planning Committee was designated as the State agency for the prosecution and coordination of the public involve-

ment program and in the adoption of the plan, and was a participating entity in the evaluation, comparison, and selection of Basin and areawide plans. The Committee also had assigned tasks in the data collection and projection program. In addition, the Committee acted as the coordinating body between the study management and the various State agencies that were providing input to the study. The State agency coordinating effort involved eight State agencies, four river authorities, eight councils of government, and nine general public representatives. Federal coordinative efforts included five Federal agencies and four members of Congress.

Study Procedure.

The procedure for accomplishment of the Colorado River Basin Wastewater Management Study involved several vital steps. With assistance from the Governor's Planning Committee, the necessary basic data were obtained from many governmental bodies, including Federal, State, regional and local agencies. The data were then evaluated and incorporated into the study framework. Technical design, evaluation and comparison of treatment systems were undertaken to reach an interim goal of the study: the meeting of water quality standards at minimum cost. Recommendations were forwarded after consideration of local conditions relating to social, economic and institutional aspects. The recommendations advanced by the results for the study are presented in the report, which included detailed and specific information on local conditions, municipal needs, and estimated costs of implementing the recommendations. Thus, the report documents the studies performed, discusses the findings, and states what course of action is recommended as well as the reason for such action.

Public Involvement Program.

Public participation in the study was sought throughout the planning effort. In addition to the normal devices, which included public meetings, workshops, newspaper releases, radio and television coverage, brochures, newsletters, and individual contacts, the Governor's Planning Committee served as a built-in tool for the public-participation phase of the study.

The Governor's Planning Committee was carefully selected to insure that all geographic areas of the Basin were represented, thereby serving as a ready means of communication between the study team and the general public.

Two public meetings were held at the initiation of the study to explain the objectives of the study and the methods and procedures which would be followed to produce the end result. These meetings were co-chaired by the Governor's Planning Committee and the Corps of Engineers. An additional formal public hearing was held prior to submission of the report to the Governor. This meeting was arranged and conducted by the Texas Water Quality Board as part of that agency's legally-required study procedures.

Four workshops were held at the initiation of the study to discuss problem areas and to sound out local interests wishes in the study. Six workshops were held at selected locations in the Basin to present to the non-metro areas of the Basin alternative treatment proposals for their consideration. Another round of workshops was conducted in each of the six metropolitan areas to present an array of alternatives for action by the metropolitan populace.

Additional public involvement effort was expended in the periodic publication and distribution of a study newsletter throughout the Basin, the appearance of study team members at speaking engagements to civic, service, and educational organizations and most particularly in the individual-contact field. Individual contacts were made in coordination with the data-gathering trips of the study team members as well as the technical inspection trips to the treatment plants throughout the Basin.

All input by the public was considered during the course of the study and, in instances where differences arose, agreement was reached that was amenable to all of the concerned parties. This rapport between the Governor's Planning Committee, the Corps of Engineers, and the general public provided a solid base for the acceptance of the plan by local interests. A more detailed discussion of public involvement is provided in Volume 2, Appendix L.

The Study Area.

The Colorado River Basin extends across Texas from the Texas-New Mexico High Plains to the middle Texas Gulf Coast and encompasses almost 42,000 square miles. The area of the Basin under consideration in this study consists of some 39,900 square miles, lying entirely within Texas. The Basin, at its widest point, spans 160 miles and covers approximately 15 percent of the State's total area. The Basin is larger than the States of Maine and Kentucky and is equal in area to the combined areas of Connecticut, Delaware, Hawaii, and Massachusetts.

The Colorado River Basin extends across several basic physiographic provinces. The upper portion traverses the Southern High Plains and is an area with characteristically poor drainage and essentially no runoff contribution to the Colorado River. This portion extends to an escarpment (Cap Rock) in Borden, Dawson, and Howard Counties where the surface topography shifts to low rolling hills punctuated by prominent mesas. This area is the North Central Plains. The central portion of the Basin is situated in the rugged topography of the Edwards Plateau and the "Hill Country", an area of steep hills with cedar-covered slopes. Southeast of the "Hill Country" the remainder of the Basin lies in the Gulf Coastal Plains region, which is moderately hilly in the northwest but grades into the flat and featureless topography of the coastal region.

The general surface geology of the Basin reflects a complex series of tectonic events such as faulting, uplifting, and downwarping affecting the stratigraphic and structural aspects of the region. Just as the geology varies along the Basin, the soils also display a gradation in character. The High Plains area has generally dark neutral sands, sandy loams and clay loams which trend into calcareous stoney clays and some clay loams in the Edwards Plateau. These gradually grade into dark calcareous clays interspersed with acid sandy loams as the Colorado River reaches the Coastal Plains. Acid to neutral sandy loams and clays are the prevalent soil type in the coastal region.

The Colorado River Basin enjoys a generally mild climate, which varies from subtropical along the Gulf Coast to semi-arid in the High Plains. Since there are no major topographic features in the Basin which affect its climate, the transition from semi-arid to subtropical is gradual and fairly uniform. Usually the summers in the Basin are hot and the winters mild except for occasional severely cold temperatures in the High Plains. The annual precipitation, primarily rainfall, increases from the High Plains to the Coast. The prevailing winds are from the south or southeast during all but some portions of the winter months when high-pressure areas from the northwest result in the wind direction shifting and coming from the north over most of the Basin. With the exception of tornadoes and the occurrence of hurricanes along the coastal areas, air movements over the Basin are generally mild.

The average annual runoff in the Colorado River Basin ranges from a maximum of 350 acre-feet per square mile near the mouth of the river to less than 50 acre-feet per square mile west of an approximately north-south line through San Angelo. There is very little, if any, streamflow in the upper 57 mile reach of the River; however, the streamflow begins to increase proportionately in a downstream progression until at Bastrop, Texas the average flow is 2,040 cfs.

Currently, there are 21 major reservoirs with capacities of 5,000 acre-feet or more in the Colorado River Basin. The primary regulating system in the Basin is the Highland Lakes networks of impoundments which has a total capacity of 2,091,610 acre-feet. Surface water is a scarce commodity in a major portion of the Basin and ground water is utilized primarily to satisfy water requirements. Nine major and minor aquifers supply an economically recoverable perennial yield of ground water that total some 538,700 acre-feet.

Population and Land Use.

The 1970 population of the Colorado River Basin was 834,747 or 7.4 percent of the State population. Although during the past decade the Basin population increased about 7.5 percent, the growth rate experienced by the State was 16.9 percent. Overall, the Basin is projected to experience a mild population growth and to continue to grow at a slower rate than the State during the entire study period.

There are four Standard Metropolitan Statistical Areas within the Basin and 31 urban areas. Although the population in the Basin is primarily urban, the land use for the Basin is mainly agricultural, with the primary municipal and industrial land uses clustered about the metropolitan areas. Approximately 60 percent of the Colorado River Basin is range and unimproved pastureland. Farming, in a broad sense, occupies another 30 to 35 percent of the Basin land area, with the scale and intensity of cultivation limited by the availability of water for irrigation. In the upper and central regions of the Basin, only about 10 to 20 percent of the potentially irrigable land is presently under irrigation.

Existing Water Quality Problems.

Fortunately, as detailed throughout this report, the Colorado River Basin has comparatively few water quality problems of a significant nature. Of the problems that do exist, stream imbalance by disproportionate amounts of secondary effluent and quality degradation by inflow of mineral salts are the most pressing concerns. Other sources of stream contamination, runoff, industrial discharges, land disposal operations, irrigation return flows, lakefront contamination, etc., detailed in this report can all be found in the Basin. In comparison, however, these sources do not bear the significance that effluent-dominated streams and mineral salt contamination have in the Colorado River Basin.

Located in a semi-arid area, a majority of the tributary streams and rivers to the Colorado River and many reaches of the main stem are either intermittent or have frequent periods of minimal flow. As a result, many streams become heavily effluent-dominated, with subsequent quality degradation through parts of the year. Beals Creek below Big Spring, and Pecan Bayou below Brownwood are significantly effluent-dominated streams. These two reaches receive concern due to the relative size of the contributing cities; however, the situation is often repeated on smaller streams by smaller cities.

Based on the methodology which supports the designation of stream segments as either effluent limitation or water quality limiting, many of the known effluent-dominated reaches by definition are designated effluent limitation segments. Utilizing the methodology which defines the wasteload allocation procedure, it is indicated that all dominated segments which are water quality limiting will not result in a violation of stream standards if municipal wastes discharged to the segment receive secondary treatment. The above-mentioned methodologies are included in the Appendixes to this report.

The other significant source of stream contamination in the Basin is the inflow of mineral salts into the waters of the Upper Basin. These are two commonly-documented sources of the total dissolved solids, chloride, and sulphate concentrations. The contaminants are usually attributed to either oil field brine pollution or to leaching of natural salt deposits. Of these, the most prevalent, plausible, and well-documented source is oil field brine. Results of prior study and investigations accomplished for this report regarding oil field wastes are included elsewhere in this report (Volume 2, Appendix D).

A third, less documented source of mineral salt contamination is the return flow from communities in the Basin where individual home water softeners are prevalent. In the operation of these units, backwashing is usually accomplished with a concentrated brine solution. The ultimate disposal of backwash water is characteristically to municipal wastewater systems which provide no reduction in salt concentrations prior to discharge to a receiving stream.

In the upper Basin, which has begun to rely heavily on surface drinking water supplies, the citizenry is eminently aware of the contamination of surface waters by mineral salts. While there may exist in that citizenry diversity of opinion as to cause of mineral salt contamination, no difference of opinion exists in the desire that rectification be accomplished.

Current Pollution-Abatement Efforts.

Current pollution-abatement efforts in the Basin have been generally local in extent. Primarily, the only measures initiated have been municipal secondary sewage treatment plants and industrial treatment facilities. Within the Basin there are 87 municipal secondary facilities and 98 industrial wastewater plants. Approximately 30 of these municipal facilities discharge effluent while 57 plants either irrigate with all effluent, irrigate seasonably with some discharge, provide for total retention, or utilize industrial reuse as the means of final effluent disposal. Of the industrial treatment plants, 68 are permitted to discharge. Of these, only 19 recorded a discharge during the period of study. The total volume discharged averaged 1125 mgd, of which 1118 mgd was from thermo-electric generating facilities.

As a structural means to alleviate the problem of high chloride concentrations entering the E. V. Spence Reservoir on the Colorado River, a structure has been constructed on the River below Colorado City to capture and divert concentrated low flows to an impoundment from which the water is drawn for oil field water-flooding operations.

Stream Quality and Water Quality Standards.

In 1967, Water Quality Requirements were established by the Texas Water Quality Board under the authority of the Texas Water Quality Act. The waters of the State were classified as inland and tidal waters and further divided into river and coastal basins, each with a numerical code. Water quality criteria for various parameters were then established for reaches of the main stream and major tributaries. These criteria have recently been updated and revised and are included herein. Pursuant to the new requirements, waste load allocation analyses were made, where necessary, for specific stream segments which have evidenced a violation of the new criteria and for those with inadequate data to date.

Current Institutional Arrangements.

In Texas, there are three major State agencies concerned exclusively with water quality, development, regulation, administration, and management. These are the Texas Water Quality Board, the Texas Water Development Board, and the Texas Water Rights Commission. The major State water agencies, together with other natural resources oriented agencies, coordinate their programs through the Interagency Council of Natural Resources and Environment, which is staffed by

the Governor's Office. The Texas Water Quality Board is the principal authority in the State on matters relating to water quality within the State and is responsible for maintaining a water quality sampling and monitoring program for Texas, establishing water quality criteria governing the discharge of wastes, conducting public hearings on all applications for said permits, regulating industrial solid waste collection and disposal, conducting research and planning toward the goal of development of a comprehensive water quality program throughout the State, and implementing water quality management plans throughout the State.

The Texas Water Development Board is the agency charged with Statewide planning for water supply. This Board also makes loans to local governmental agencies sponsoring the construction of projects for the conservation and development of water resources in the State and with acquiring reservoirs and associated facilities to be constructed on Texas streams.

The Texas Water Rights Commission's primary role is to regulate the use of Texas public (surface) water to the end that it will be conserved and used for the greatest public benefit and in the public interest.

Various other agencies are included in the institutional arrangements as the jurisdictional boundaries are decreased. Details of these agencies are presented in Volume 4 of this Report.

Segmentation and Waste Load Allocation.

PL 92-500 has placed increased emphasis on segmentation. Under the Public Law, the segment--simply defined as any body of water, stream, reach or coastal area for which specific water quality standards have been delineated--appears to be the basic unit, or level, of the water quality management planning effort. This effort provides a uniform manner in which to set priorities and levels of treatment while meeting the 1977, 1983, and 1985 goals as a minimum.

Section 303(e) of the Law requires the State to designate such segments, and classify them as to their compliance with the stream standards. Once this designation has been made, discharges are to be ranked within the segment and within the State--one list each for municipal and industrial discharges. Having established these priorities, or rankings, the maximum daily loading of a segment is evaluated, where necessary, and waste load allocations made, where required, to effect compliance with stream standards.

Incident to the enactment of PL 92-500, and subsequent implementation by EPA, the Texas Water Quality Board has reevaluated the Water Quality Requirements of 1967. These revised standards present water quality criteria for 284 segments, as opposed to the 185 zones or segments delineated in the 1967 Water Quality Requirements. The large number of segments aptly indicates the spirit of the Law; that is, to identify segments on a level where realistic and effective remedial action can be taken to both abate and prevent pollution.

Under the proposed standards, segment status has been afforded to 13 reservoirs in the Basin as opposed to one in 1967. Further, the tidal portion of the River has gained segment status.

Subsequent to the designation of the stream segments, the instream water quality of each segment was reviewed in light of the respective proposed standards for the segment. Upon completion of the evaluation, the segment was classified as being either effluent limitation or water quality limited. The distinction of the two classifications is as follows:

> Effluent Limitation Segment - (1) the water quality does not exceed the proposed standards for the respective segment and will continue to be so with the application of "secondary" treatment for municipalities and best practicable control technology for industry; or (2) although the instream water quality currently violates the proposed standards, application of best practicable control technology for industry and "secondary" treatment for municipalities will result in compliance with the proposed standards.

> Water Quality Limited Segment - (1) the instream water quality is currently in violation of the respective proposed standards and will continue to be so, even with the application of best practicable technology for industry and "secondary" treatment by municipalities; (2) there are insufficient instream quality data to verify either compliance or violation of the proposed standards.

There are numerous significant water quality parameters which should be considered in determining the compliance of a stream with the proposed stream standards. However, in view of the urgent need to develop an initial classification system, only three basic yet significant "key" parameters--pH, total dissolved solids (TDS), and dissolved oxygen (DO) --

were used in determining the compliance of the instream water quality with the respective proposed standards for the segment. While only three "key" parameters were evaluated, it is believed that they provide an adequate basis upon which to base the initial segment classification. The end product of the classification procedure resulted in only 9 of the 25 segments in the Basin being classified as effluent limitation. In fact, with the exception of Beals Creek (which is not a specific segment) and Pecan Bayou, all of the principal tributaries are effluent limitation segments. Ten of the sixteen water quality segments were so classified due to the lack of sufficient instream water quality data. Nine of these ten are reservoirs and, upon receipt of sufficient information, it is very probable that these segments will be reclassified to effluent limitation. With the exception of segment 1413, Lake J. B. Thomas, all of the water quality segments in which violations were experienced are stream segments.

Once the respective rankings for segments and discharges were determined, a "plan of action" was developed to bring all non-compliant segments into compliance by 1977. Each of six Water Quality Limited (with data) segments was examined individually and a specific course of action developed for that segment. Since Effluent Limitation segments were currently in compliance, and by definition are projected to remain so during the next five years, no maximum daily load and incident waste load allocations analysis was required on these segments. Therefore, any discharge to an effluent segment must be in compliance with the national effluent guidelines as delineated in the Act. These guidelines are summarized as follows:

	Discharges From Respective Treatment Facilities	
Target Date	Public (Municipal)	Non-Public (Industrial)
1977	Minimum of secondary treatment	Best practicable control technology
1983	Best practicable control technology	Best available technology economically feasible
1985	No discharge of pollutants	No discharge of pollutants

In developing the course of action for a segment, the primary purpose was to develop a program aimed specifically at bringing the respective non-compliant parameter(s) into compliance. The procedure, performed for each non-compliant parameter, utilized in the development of the program consisted of the following three separate yet integrally associate steps:

1. Determine the assimilative capacity of segment

2. Assess current loading conditions

3. Allocation of waste loads per discharge

Basin Alternatives.

Several classical methods for meeting the water quality objectives of the study were explored. These alternatives included treatment, relocation of discharge, diversion from Basin, flow regulation (augmentation), instream modification, water reuse, control of wastewater quantities by zoning and/or planning growth, and combinations of the alternatives.

In meeting water quality objectives, or any objectives for that matter, there is generally never one specific answer to the many problems. As the problem of meeting these objectives is complex, so is the solution. In evaluating the Basinwide alternatives above, those believed to be feasible, at least with respect to consideration in this study, are as follows:

1. Treatment

2. Relocation of Discharge (regionalization)

3. Water Reuse

4. Control of Wastewater Quantities by zoning and/or Planned Growth

It can be seen that these individual alternatives may be utilized in conjunction with each other in arriving at the best possible solution to the problem. For example, if treatment is in existence at a municipality by two or more separate treatment plants, regionalization of two or more plants may be more economically advantageous over the study period. At the same time, zoning and planned growth may be beneficial to treatment, regardless of the number of facilities utilized. Treatment

and Water Reuse are already a feasible combination, as evidenced by its being used in the Basin at the present time.

Finally, it may be desirable to incorporate all four alternatives at the same time. As an example, zoning and planned growth may complement treatment which may occur at one or more plants, followed by reuse of the effluent by industrial and/or agricultural purposes. As mentioned before, agricultural use of the effluent may further enhance the treatment process either by producing a high quality effluent or eliminating the discharge altogether.

The enactment of PL 92-500 brought about an entirely new concept across the nation to eliminate all pollution of the nation's waters. Provisions of this law ruled out all alternatives that had been previously considered with the exception of the treatment alternative, which is the only condition that meets the intent of the new law in relation to the control of domestic and industrial point sources of wastes. The combination of treatment with reuse or regionalization is considered as a treatment alternative, since treatment is the most essential component of the combinations. The control of wastewater quantities by zoning and/or planned growth is now part of the plan preparation, in accordance with 40 CFR Part 131 (Federal Register, Vol. 38, No. 99) and is therefore not considered a Basin plan alternative.

Based on the preceding evaluation, the treatment alternative, alternative (1), was selected for implementing the water quality requirements of PL 92-500. Different types of treatment systems such as biological systems, physical/chemical systems, and land disposal systems in combination with biological secondary systems or physical/chemical secondary systems were considered for domestic and industrial point sources of wastes.

<u>Non-Metropolitan Areas.</u>

In essence, all proposals presented in the area-wide plans accompanying and providing a basis for this report can be classified as either a discharge or no-discharge of effluent alternative. Characteristic of the semi-arid Colorado River Basin of Texas is the need for utilization of treated wastewater flows to supplement the agricultural economy. It is for that reason that a majority of the proposals contained in the area-

wide plans look to wastewater reuse through agriculture as the most cost-effective method of providing a high degree of treatment. So as not to preclude a local option to the proposed method of treatment, a logical alternative treatment method was conceived and associated costs generated.

Metropolitan Areas.

As a special directive to the participants in this study, it was desired to develop a minimum of ten alternative treatment schemes to meet stated water quality objectives for each of six metropolitan areas. These metropolitan areas were defined as Austin, Big Spring, Brownwood, Midland, Odessa, and San Angelo, Texas. The water quality objectives were twofold. First a single plan was required to meet a waste load allocation. Pursuant to passage of the PL 92-500, initial mathematical modeling investigations and waste load allocation calculations, this plan evolved into a plan to meet the objectives and milestones of the law. Second, nine alternatives were to be developed to meet the highest level of treatment goals utilizing biological, physical-chemical, and/or land disposal techniques. In addition, regionalized treatment was to be considered in certain specific instances.

Water Quality Management Strategy.

In the formulation of this report, an attempt was made to collect and review all area-wide planning throughout the Basin which had been accomplished to date. The central responsibility in the collection effort fell to the Governor's Office, Division of Planning Coordination.

In the classic planning process, a Basin Plan is first accomplished followed by respective area-wide planning directed toward the goals established by the Basin Plan. Since a vast amount of local and regional area-wide planning had been accomplished prior to initiation of this effort, the scope of the Colorado River Basin Wastewater Management Study was broadened to include development of comprehensive area-wide plans concurrent with the Basin Plan.

Toward development of the area-wide planning documents accompanying this report, Volumes 5, 6 and 7, the planning included in each prior report pertaining to a given area or municipality was assessed for its validity and incorporated where possible in the area-wide plan formulation. Where no area-wide planning was known to be in existence, initial plans were formulated based on needs of the region and available soil and topographic data, utilizing the best judgment possible. At all times during the area-wide plan formulation, the area planning was cognizant of and responsive to the objectives the Basin Plan was pursuing.

It was not the intent of this study to supersede all prior area-wide planning documents; rather, the prior documents were to form a base for the comprehensive planning accomplished in conjunction with the Basin Plan. Every attempt was made by the Governor's Office, Division of Planning Coordination, the Texas Water Quality Board and the Corps of Engineers to locate and incorporate all existing studies. If published planning reports have been inadvertently omitted from consideration, it is hoped the respective municipality or agency will bring these documents to the attention of the Texas Water Quality Board for their consideration in the State's continuing planning process.

In addition, this plan does not supersede, without the application of those procedures specified by State law, any permit, waste control order, registration or order of the Texas Water Quality Board. Wherever the general or specific requirements of this water quality management plan in its present form, or as it may later be amended, provide for waste control requirements authorized by permit, registration, waste control order, or other order, the Board will, following the procedures set forth by law, review and evaluate the waste control order or similar authorization and may amend it, revoke it, or take any other action deemed appropriate by the Board. Nothing herein deprives the holder of a waste control order or other similar authorization from exercising any and all legal rights that he may otherwise have in his own defense. This water quality management plan, despite its specific nature and great detail, contemplates that all actions growing out of this plan are intended to be carried out within the framework of appropriate laws, procedures, regulations and reviews.

In the area-wide planning sections of this report, a minimum of two basic alternatives were developed for each private or publicly-owned domestic wastewater treatment facility to meet water quality objectives. In the refinement of an overall strategy to meet the water quality objectives of the Basin Plan, the apparent most cost-effective plan for each facility was selected and carried forward into the development of construction needs and Basinwide system of fiscal resource allocation priorities.

The milestones utilized to develop the construction needs and priority listings were those of PL 92-500. Three construction-needs lists were therefore developed; one to meet each of the law's objectives of 1977, "secondary treatment"; 1983, "best practicable waste treatment technology"; and "no discharge of pollutants." The rationale and methodology defining and accomplishing these objectives is contained in Volume 3 of this report. The listings by definition become construction compliance schedules if the goals of the law are to be met.

In order to develop a Basin-wide listing of construction priorities, a ranking was devised that utilized three key elements and associated weights.

The ranking of the Facility Construction Elements was based on the philosophy of lending priority to the alleviation of water quality problems associated with prior-constructed facilities. By construction of a collection and treatment system, a point source of pollution is created, and responsibility then exists to ensure that the facility continues to produce an acceptable quality effluent. For this reason, in the allocation of a fiscal resource, modifications, expansions, and replacement of existing secondary facilities should have more weight than improving the level of general treatment throughout the Basin.

To compensate for relative location within the Basin, the stream segments into which the proposed facilities would discharge have been given weights comparable with the segment's relative ranking within the Basin. The rankings were compiled by the Texas Water Quality Board under the methodology described in the Appendixes to this report.

Finally, a weight was given to the facility according to the facility's method of effluent disposal. In the national effort to eliminate the discharge of pollutants, significance is noted and has been placed on the effort of municipalities to seek agricultural or industrial reuse of wastewater.

Actual priority ranking was made from a totalization of all weights associated with a construction project. In instances where the weight totals for two or more projects were numerically the same, the influent BOD loadings to the facility were utilized to rank the projects. In this ranking, priority was given to the facility with the greatest influent load.

Conclusions, Recommendations and Financing.

The Colorado River Basin Wastewater Management Study was commissioned to effect Basin and area-wide comprehensive planning for the Colorado River Basin, Texas and to provide direction for the many communities within the Basin which have responsibility to comply with State and Federal water quality requirements. In addition, the Basin and area-wide plans which were formulated fulfill one of the required prerequisites for communities in the Basin to be eligible to receive assistance grants for needed construction of wastewater treatment facilities when these funds become available.

In the course of the study, all municipal wastewater treatment facilities in the Basin were visited and evaluated as to their physical condition and operation and maintenance status. The existing plants were found to have been maintained in varying states of condition according to the level of operator attention. Operational status was not always judged acceptable by the Corps of Engineers due to the lack of adequately trained full-time operators of functional equipment. It is believed that upgrading of existing facilities should be given the highest priorities in any program of pollution abatement.

The only alternative that meets the intent of the PL 92-500 is the "treatment" alternative. However, reuse and regionalization alternatives were included with the treatment alternative, where feasible, in order to maximize efficient utilization of wastewater and economies of scale. Basically, PL 92-500 delineated three objectives to be accomplished as a minimum implementation schedule. Secondary treatment of wastewater would be initiated by 1977, the best practicable waste treatment technology would be implemented by 1983, and, finally, a "no discharge of pollutants" status would be attained. The total approximate costs, including non-metropolitan and metropolitan areas, to meet the water quality objectives by two basic alternatives, treatment with discharge and treatment with reuse (no discharge), are as follows:

Alternative Funding Levels
To Meet
Water Quality Objectives

Alternative	1977 Objective	1983 Objective	NDP
No Discharge	$25,339,470	$30,733,270	$ -0-
Discharge	30,369,400	36,355,900	25,760,800

The alternatives in the preceding table refer to two basic methods of effluent disposal. The no-discharge alternative utilizes land disposal or irrigation of effluent, and the discharge alternative presents a method of disposal whereby all possible pollutants are removed by either biological or physical-chemical processes. From feasibility analysis conducted throughout the study, it was ascertained that land disposal of effluent is the only practical method available to small cities to enable them to meet existing and future water quality requirements. However, due to local climatological,

geographical, topographical, and land availability considerations, the single alternative which would be the recommendation of this study could be either of the alternatives. Therefore, the above cost summary should not be utilized in the context of the single level of fiscal resource required for the Colorado River Basin. The most practical alternative for three of the metropolitan areas--Midland, San Angelo and Odessa--would be to continue their present method of effluent disposal through agricultural or industrial reuse of treated wastewater. Recommended alternatives for the metropolitan areas of Austin, Big Spring and Brownwood would include some form of conventional tertiary treatment and possible plant expansion or renovation where applicable.

In the completion of this study effort, a construction-needs list and a priority listing were developed to indicate the level on construction effort required to place the Basin in compliance with PL 92-500. The methodologies utilized in the development of these listings are presented in Section VIII of this report. In summary, a single alternative for each facility was selected and presented with its associated capital expenditure estimate. The summation of the recommended alternative for all facilities results in the required levels of expenditure are as follows:

Recommended Funding Levels
To Meet
Water Quality Objectives

Year:	1977 Objective	1983 Objective	No Discharge of Pollutants
Expenditure:	$26,031,000	$23,865,300	$8,034,300

It is thus felt that the upgrading and maintenance of water quality in the Colorado River Basin can be a feasible project. Viable alternatives for wastewater treatment and disposal have been presented to enable each municipality within the Basin to comply with PL 92-500 and State water quality criteria. The implementation of these plans is now the responsibility of each individual municipality and the State implementing agency, the Texas Water Quality Board.

Sincere appreciation is expressed to the Governor's Office, Division of Planning Coordination, the Texas Water Quality Board, all Regional Planning Councils, many municipalities, numerous consulting engineering firms, and many others who contributed data and reports toward this study effort.

It is recommended that the "treatment" alternative, in conjunction with reuse and regionalization, where feasible, be utilized as the implementation strategy throughout the Colorado River Basin, Texas.

II. BASIN DESCRIPTION

Physical Description.

Location.

The Colorado River Basin, Texas (Figure II-1), constitutes the larger portion of the Colorado River Basin which extends diagonally northwest to southeast from the Lea-Chavez county line in southeastern New Mexico to the central Texas Gulf Coast. Throughout its near 595 mile traverse (540 miles in Texas) the Basin encompasses 41,763 square miles, of which 39,893 square miles are in Texas and 1,870 square miles in New Mexico. Of the total Basin area, 10,030 square miles in Texas and the entire Basin in New Mexico is considered hydrologically noncontributing. That is, any runoff in this area drains into sinks and playa lakes and thus does not contribute to the stream flow in the river per se.

Geographically, the Basin[1] is bounded on the north and east by the Brazos and Brazos-Colorado Coastal Basins, respectively. The Neuces, Guadalupe, Lavaca and Colorado-Lavaca Coastal Basins border the Basin to the south, while the Rio Grande River Basin adjoins the Basin to the west.

The Basin, which is the third largest in Texas, includes all of,or a portion of, 62 counties in the State. Its 39,893 square miles--which is approximately 6,000 square miles more than the total area covered by the States of Connecticut, Delaware, Maryland, Massachusetts, New Jersey, Rhode Island and the District of Columbia--represent approximately 15.2 percent of the State's total area.

Physically, the Basin is about 70 miles wide in the High Plains and 110 miles wide near Colorado City. It reaches its maximum width of about 160 miles in the Brown-McCulloch Counties vicinity, only to taper off to about 30 miles wide at Austin, and a width of 15 miles at Columbus.

The Colorado River proper originates in north-central Dawson County about eight miles northeast of Lamesa. The river meanders southeasterly 894.2 miles across numerous geological formations to the Gulf of Mexico. During its traverse, the physical size and nature of the stream channel changes notably and the streambed profile drops, at no

(1)The Colorado River Basin, Texas

uniform rate, 2,780 feet. The streamflow, which varies from no flow to several thousand cubic feet per second, in the Colorado River is regulated to various degrees by sixteen major reservoirs, primary of which are the Highland Lakes.

The Colorado River system consists of the main stream and its six principal tributaries: Beals Creek, Concho River, Pecan Bayou (farthest west bayou in the United States), San Saba River, Llano River and the Pedernales River. All of the major tributaries enter the Colorado River above Austin, and Pecan Bayou is the only principal tributary that enters the Colorado River from the east. With the exception of Pecan Bayou and Beals Creek, the major tributaries are spring-fed streams which head in the Edwards Plateau. Pecan Bayou heads in central Callahan County, and its flow is regulated by Lake Brownwood. Beals Creek heads at the natural Salt Lake east of Big Spring.

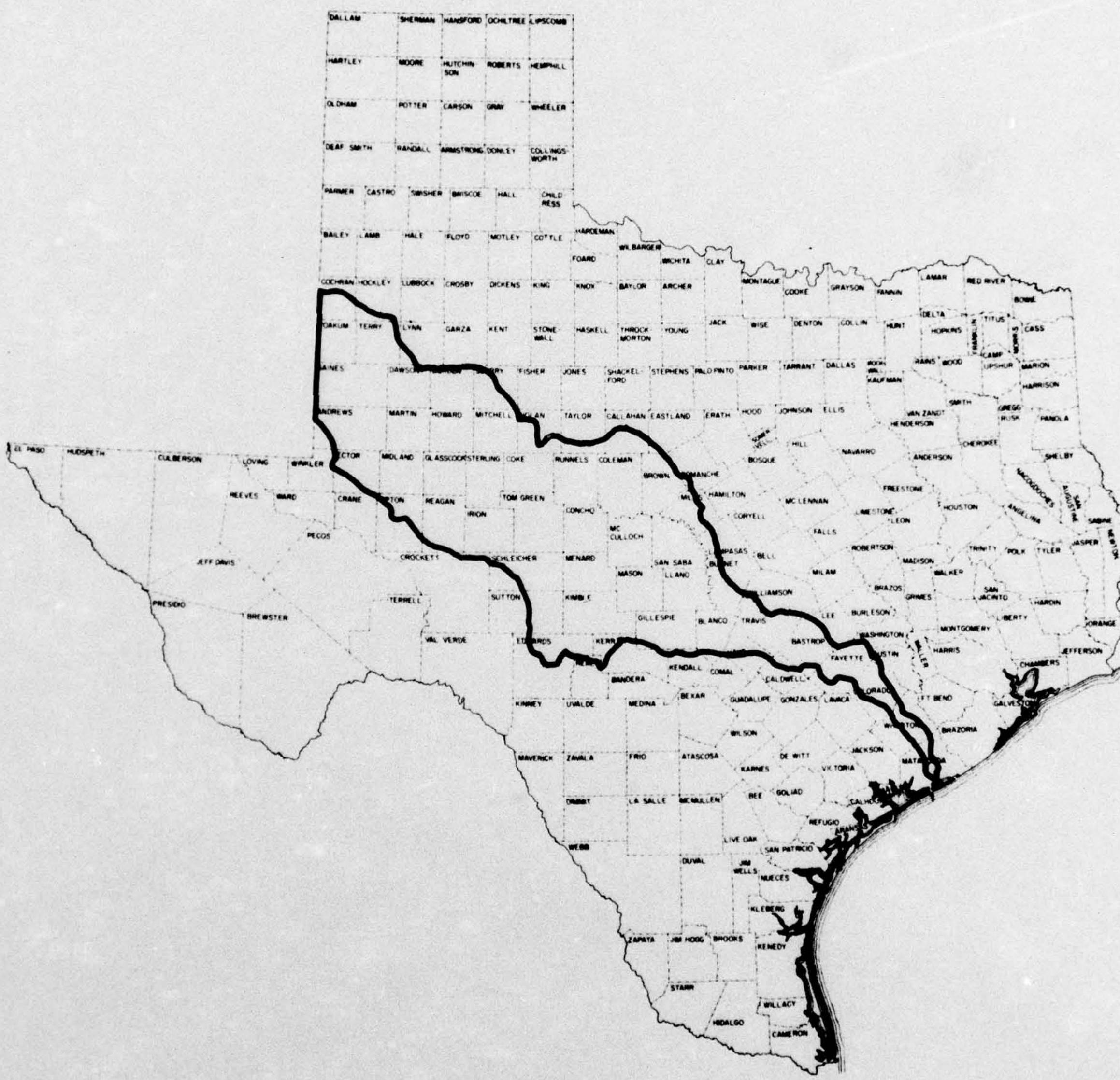
For the purpose of this study, the Basin has been divided into four hydrologic regions. This division was made to enable a more comprehensive analysis of the water quality problems in the Basin. As seen in Figure II-2, the region delineation is as follows:

Region	
I	Mouth of the Colorado River to Mansfield Dam at Lake Travis
II	Mansfield Dam to the confluence of the Colorado and San Saba Rivers
III	Confluence of the Colorado and San Saba Rivers to the source of the Colorado River
IV	The so-called noncontributing area of the Basin

Climate.

The Colorado River Basin enjoys a generally mild climate, which varies from subtropical along the Gulf Coast to semiarid in the High Plains. Since there are no major topographic features in the Basin which effect the Basin climate, the transition from semiarid to subtropical is gradual and fairly uniform. The change of seasons is hardly discernable in the lower portion of the Basin, and only slightly so as you go upstream. Usually the summers in the Basin are hot and the

FIGURE II-1
LOCATION MAP
COLORADO RIVER BASIN, TEXAS



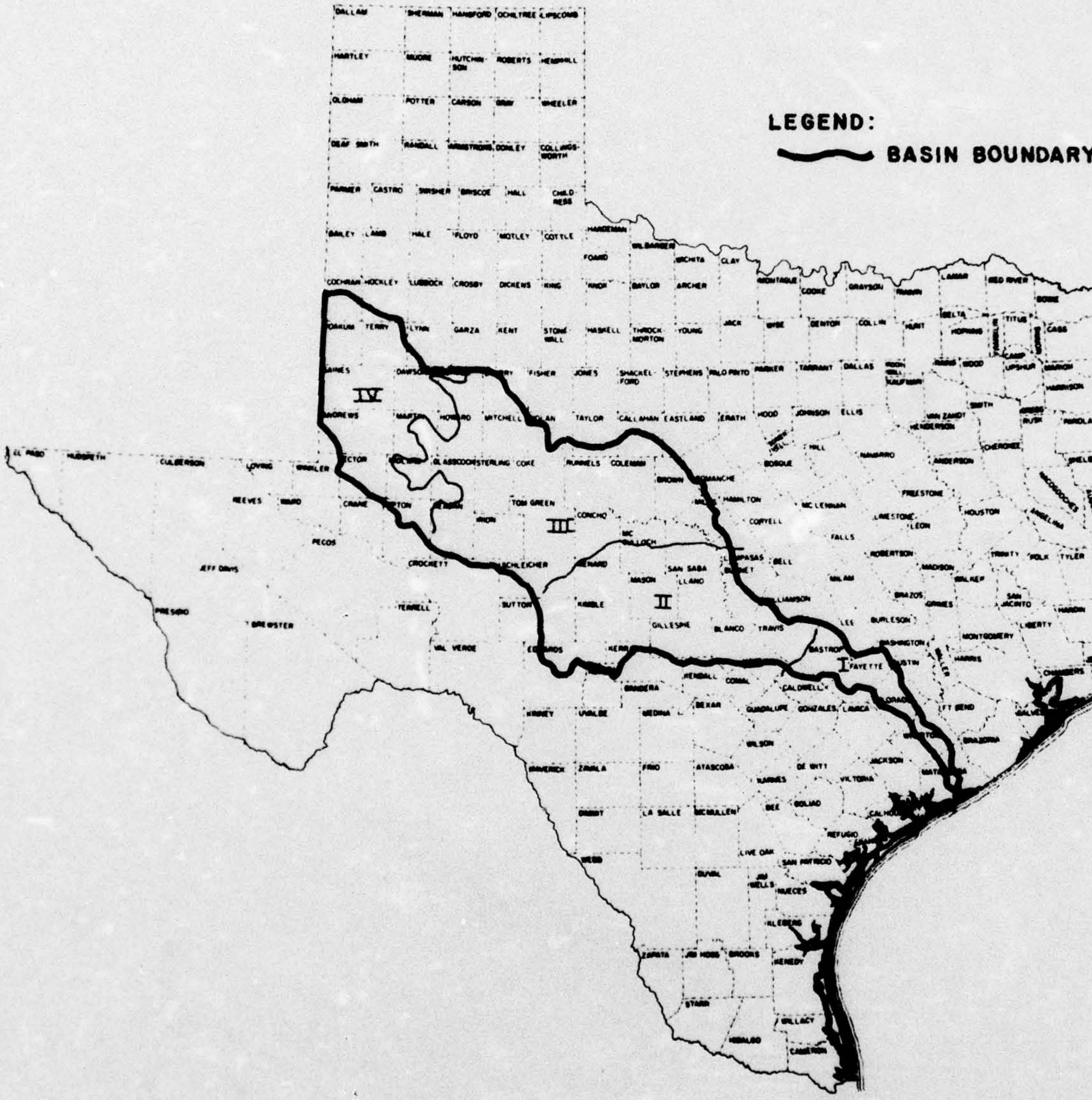
LEGEND:

BASIN BOUNDARY

FIGURE II-2

SELECTED HYDROLOGIC REGIONS

COLORADO RIVER BASIN



winters mild, except for occasional invasions of polar air masses during the winter.

The annual average temperatures (Figure II-3) over the Basin are moderate, ranging from 70°F in Matagorda County to 59°F in Cochran County. Mean maximum summer temperatures in the Basin range from 100+ °F in the upper portion to approximately 90°F at the Coast, while mean maximum winter temperatures range from 52°F to 64°F respectively. Subzero temperatures have been recorded in the Basin as far south as Smithville.

As with temperature, there is a gradual increase in precipitation from the High Plains to the Coast. The primary form of precipitation in the Basin is rainfall, with snow occurring only in small amounts usually in the northwestern portion of the Basin. The intensity and frequency of rainfall varies throughout the Basin. Average annual rainfall (Figure II-4) values range from about 40 inches in Matagorda County to a mere 12 inches in Winkler County. Conversely, the average annual gross lake-surface evaporation rate (Figure II-5) ranges from about 50 inches per year at the Coast to about 80 inches per year in the northwestern part of the Basin.

Like rainfall, humidity is decidedly higher along the coastal areas. This is primarily due to the proximity to the Gulf of Mexico and the warm, humid air which bathes the coastal area. Mean January and July dewpoint temperatures illustrate the fairly uniform decrease of atmospheric moisture, both winter and summer, with increasing distance from the Gulf of Mexico (Figure II-6).

The prevailing winds are from the south or southeast during all but portions of the winter months when high pressure areas coming from the northwest result in wind direction shifting and coming from the north over most of the Basin. With the exception of periodic tornadoes, and the occasional hurricane or other tropical storm which mainly affects the coastal area, the air movements over the Basin are generally light.

<u>Physiography.</u>

The Colorado River Basin extends primarily across three basic physiographic provinces (Figure II-7): the Great Plains, North Central Plains and the Gulf Coastal Plain, as it traverses the State. There is a significant change in the physiographic expression of the Basin in the

three provinces. The exact extent of this change is illustrated in the following discussion of the physiographic regions (constituent parts of a physiographic province) within the Basin.

The upper part of the Basin traverses a portion of the Southern High Plains. The Southern High Plains extend from the Texas-New Mexico State line to an eastward-facing escarpment ("Cap Rock") in Borden, Dawson and Howard Counties. The topography of the area rises gently from 2700 feet on the east to more than 4000 in spots along the New Mexico border. The drainage in the area is very poor and, as such, most of the Southern High Plains portion of the Basin (approximately 6,400 square miles) contributes no runoff to the Colorado River.

East of the escarpment, the Basin crosses the North Central Plains. The surface topography of this portion of the Basin is characterized by low rolling hills, punctuated by prominent mesas. The bench topography of the area is covered with mesquite and prairie grass.

Downstream from the area of the North Central Plains, the topography changes to the more rugged features of the Edwards Plateau and the "hill country." The Edwards Plateau varies from about 750 feet high at its southern and eastern borders to about 2700 feet. The Plateau is covered by a medium to thick growth of cedar, small oak and mesquite. The considerable relief observed in the Plateau has resulted from the dissection of the limestone formation by numerous streams. The "hill country" is generally an area of steep hills with cedar-covered slopes. However, its central part, west of Austin, sometimes called the "Central Mineral Region," is characterized by bald "granite" hills of moderate relief.

Southeast of the "hill country" the remainder of the Basin lies in the Gulf Coastal Plain. The boundary between the "hill country" and the Gulf Coastal Plains is abrupt and is marked by the southeast-facing Balcones Escarpment (Fault Zone) which passes through Austin. The northwest portion of the Plain is moderately hilly, while the terrain in the remainder of the coastal region is flat and featureless plains, with an elevation varying from 0 to 250 feet above sea level.

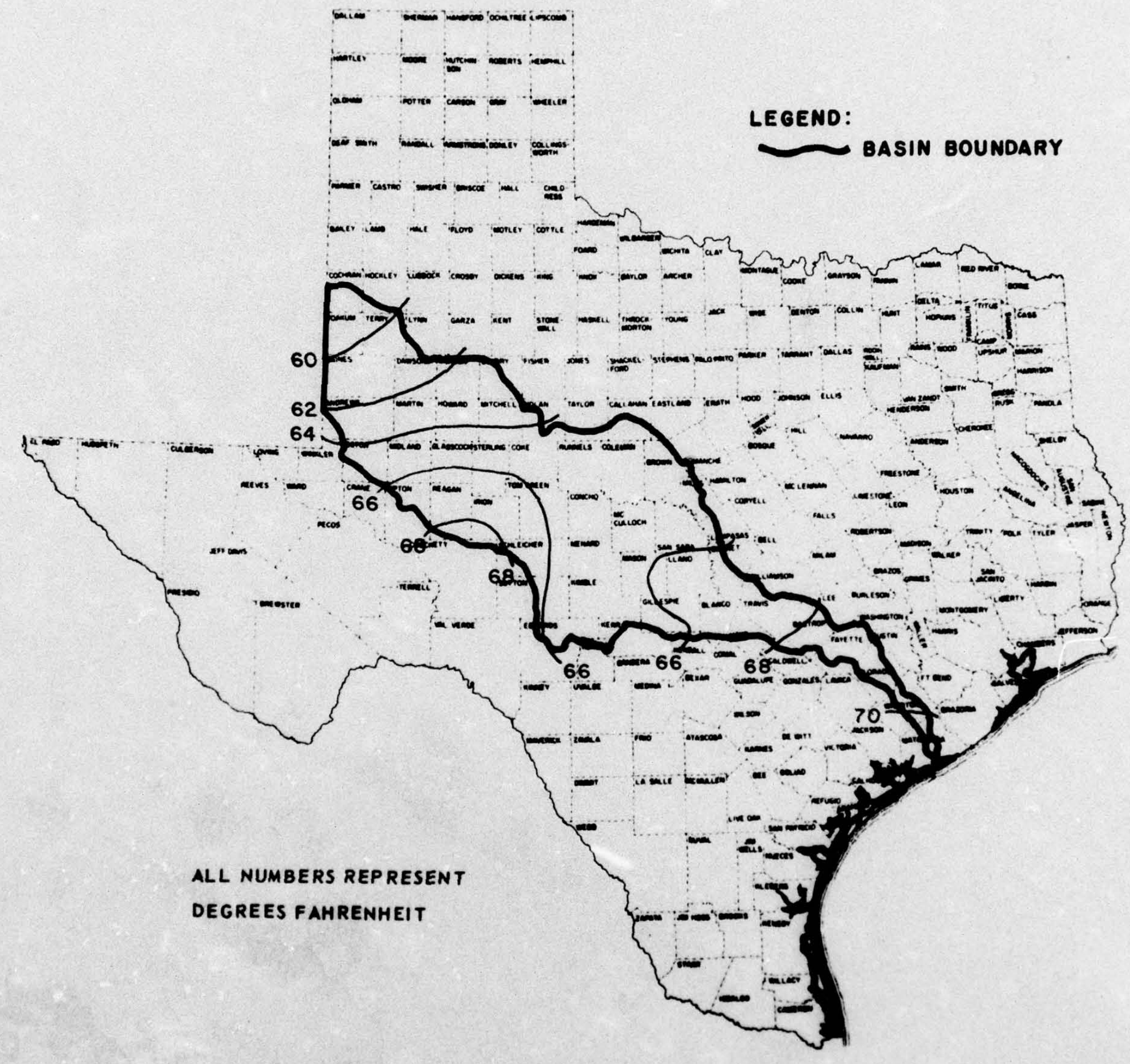
Geology.

The general surface geology of the Basin (Figure II-8), like most of Texas, reflects a variety of complex stratigraphic and structural controls. The High Plains consists primarily of the Phorine formation (Ogallala sand and gravel). Pre-Cambrian granites, gneiss and schist occur in the area

FIGURE II-3

MEAN ANNUAL* TEMPERATURE

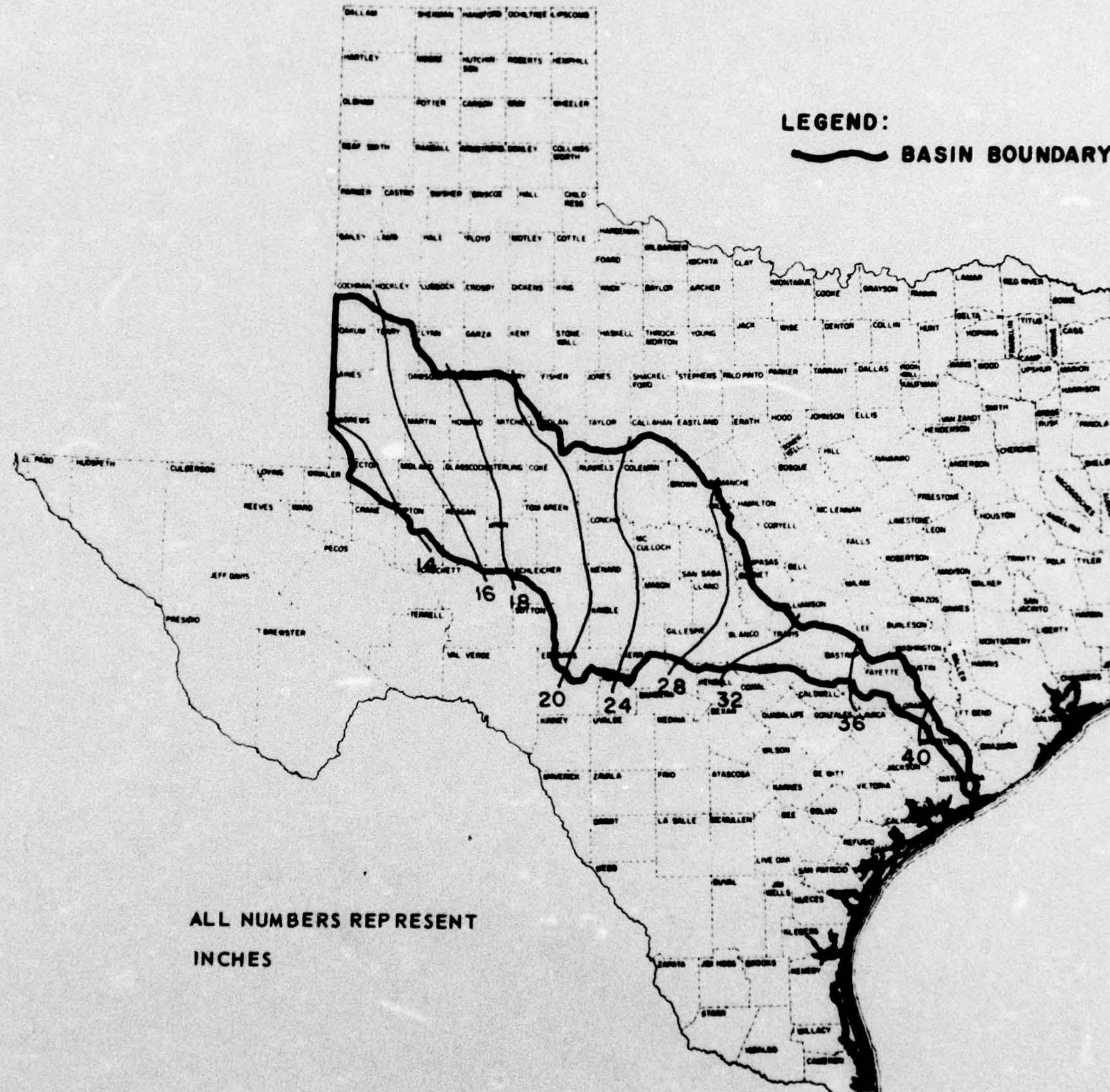
COLORADO RIVER BASIN



*1931 - 1960

SOURCE: *Texas State Climatologist*
U.S. Weather Bureau, Austin, Texas, 1966.

FIGURE II-4
MEAN ANNUAL* PRECIPITATION
COLORADO RIVER BASIN

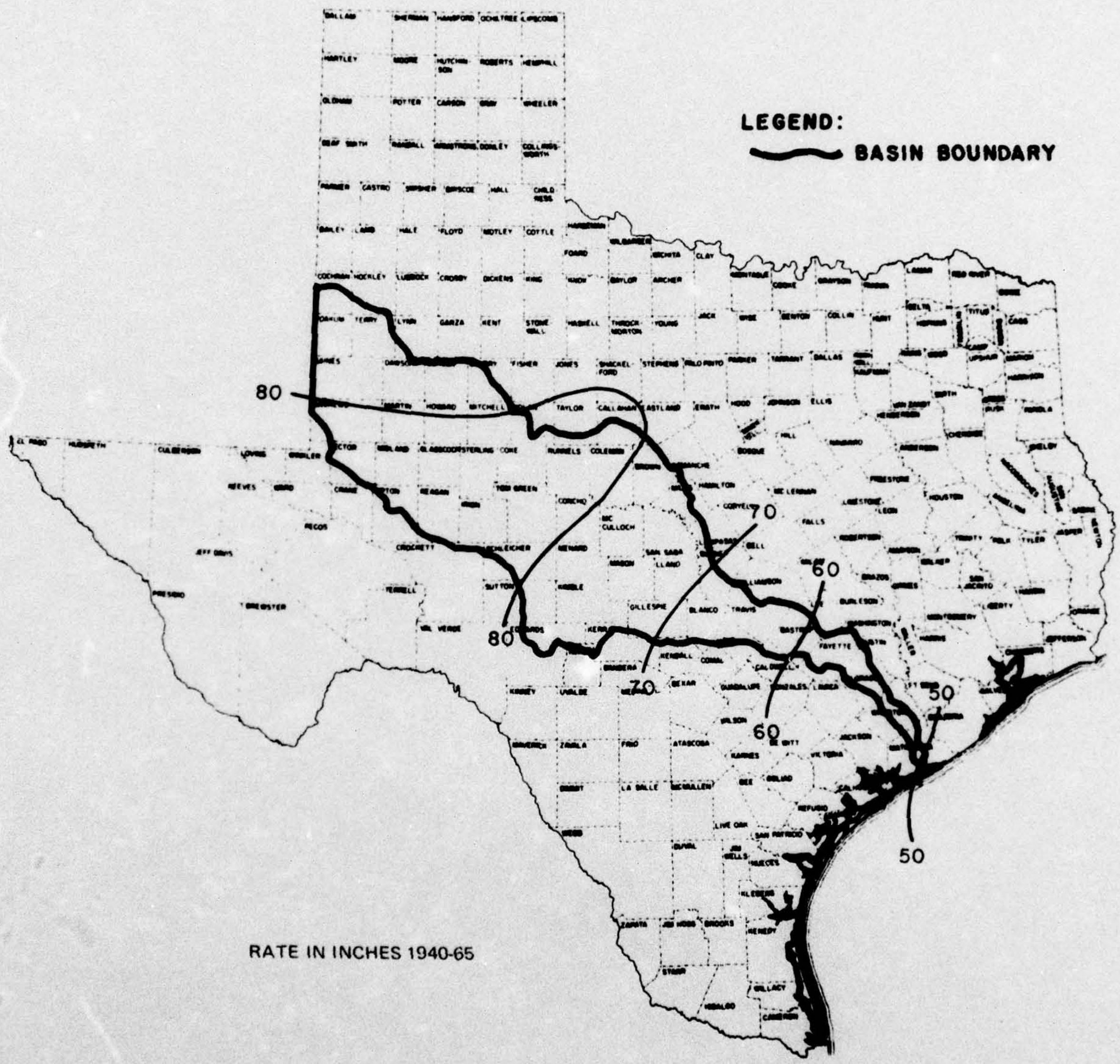


ALL NUMBERS REPRESENT
INCHES

*1931 - 1960

SOURCE: Texas State Climatologist
U.S. Weather Bureau, Austin, Texas, 1966.

FIGURE II-5
AVERAGE ANNUAL GROSS LAKE SURFACE EVAPORATION
COLORADO RIVER BASIN

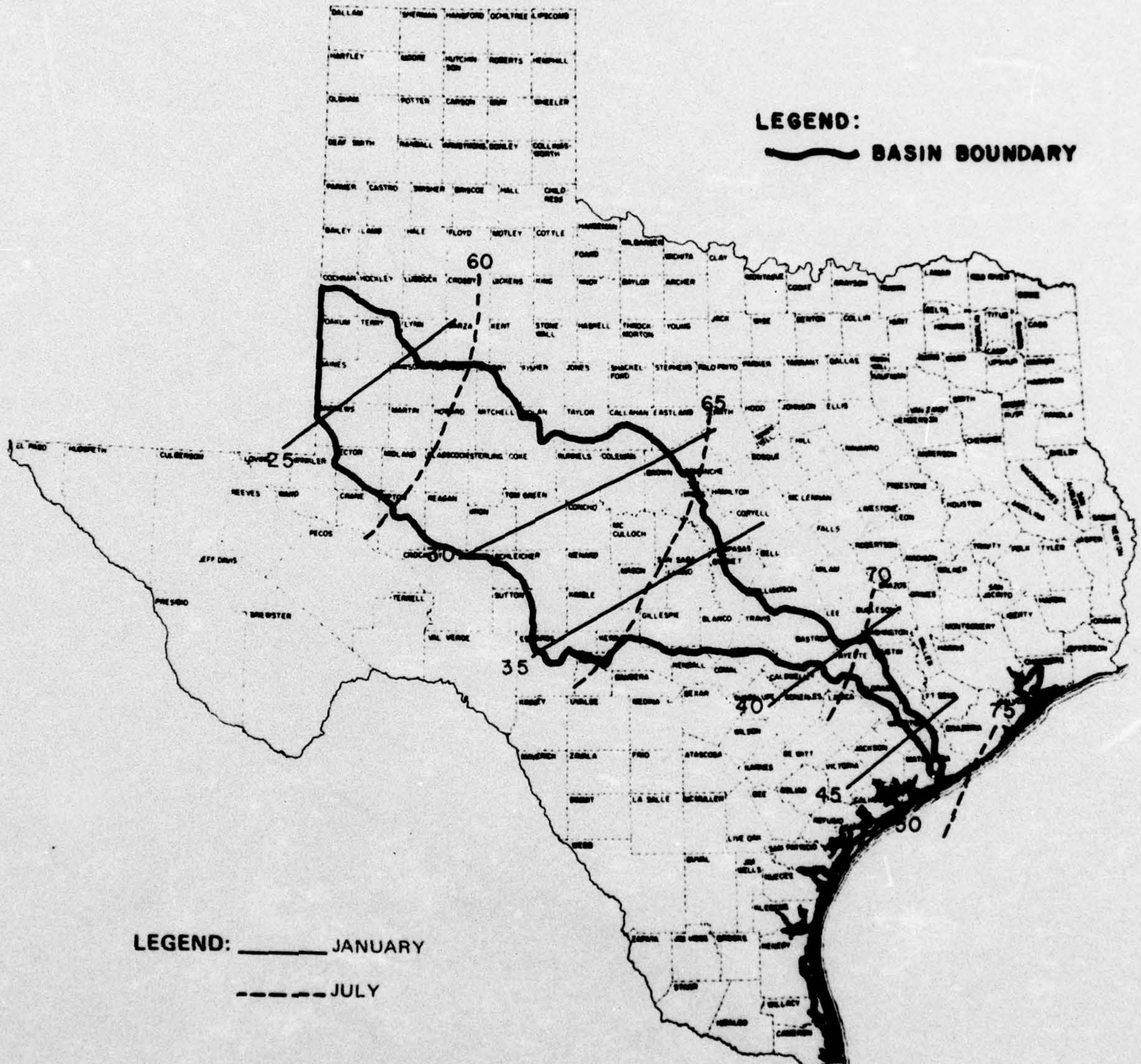


SOURCE: Texas Water Development Board
Austin, Texas, Report 64, 1967.

FIGURE II-6

MEAN JANUARY AND JULY DEWPOINT TEMPERATURES(°F)*

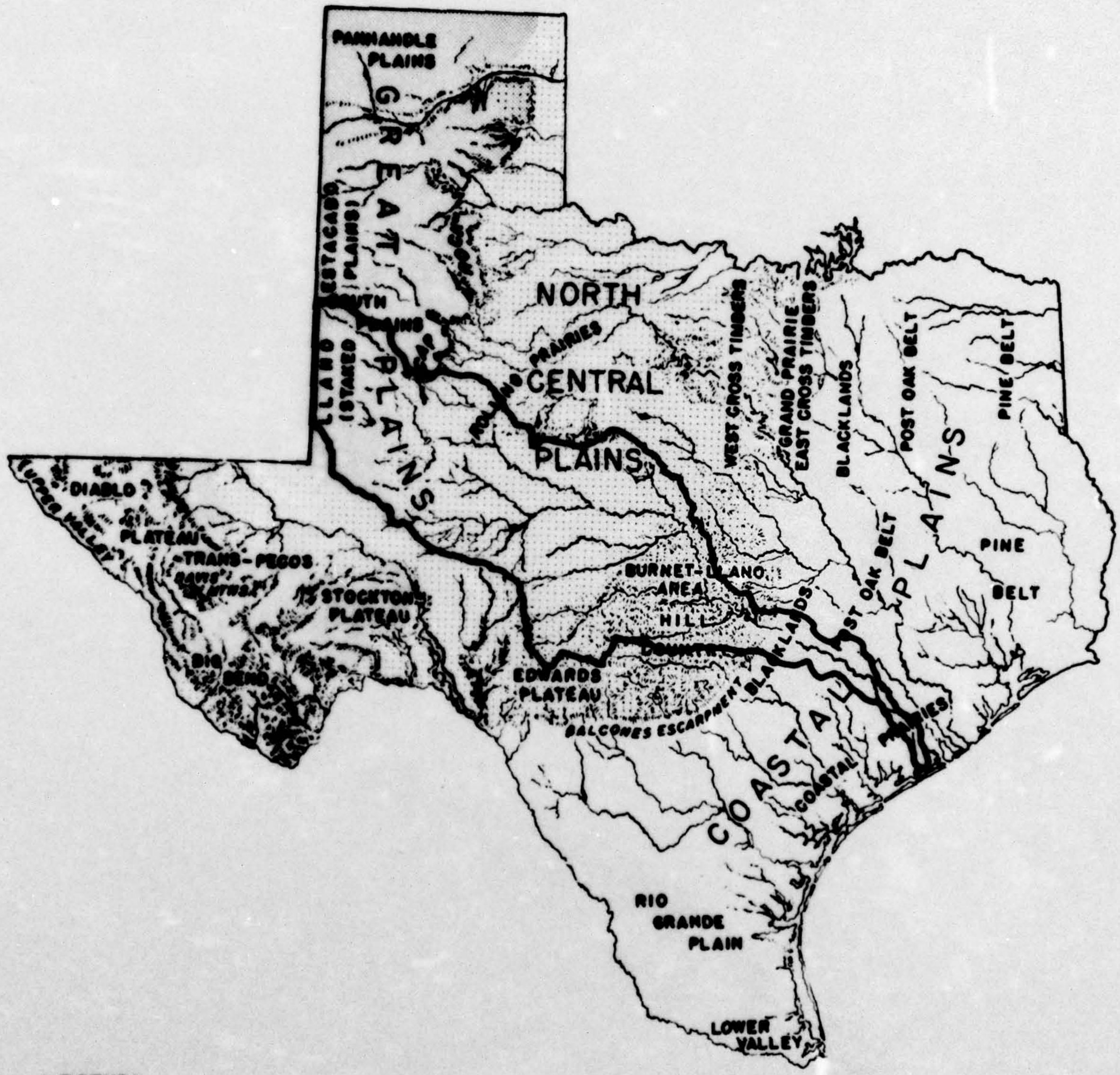
COLORADO RIVER BASIN



*Based on the period
1946-1965

SOURCE: Climatic Atlas of
the United States, Environmental Data Service

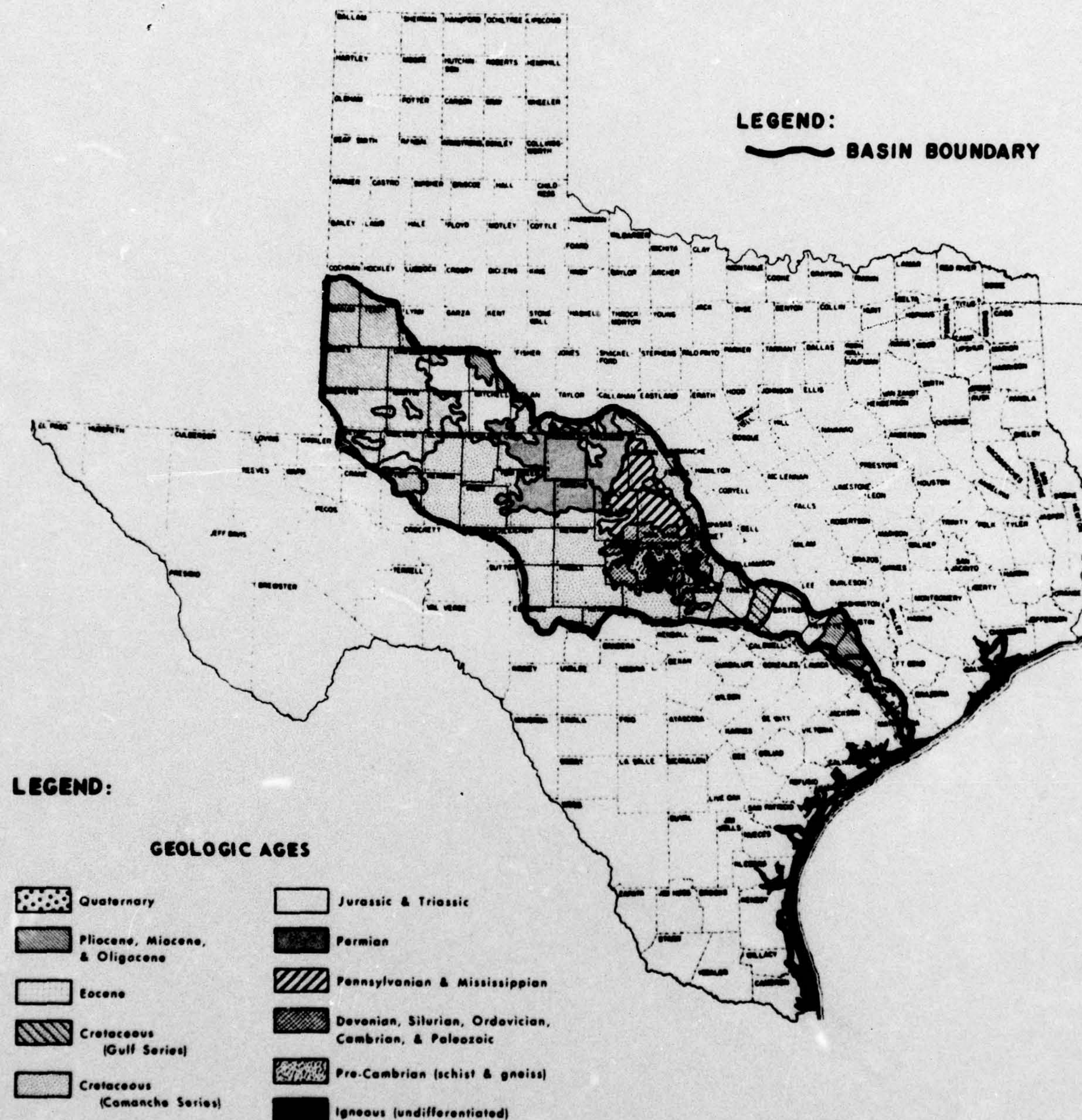
FIGURE II-7
COLORADO RIVER BASIN
IN RELATION TO PHYSIOGRAPHICAL REGIONS OF TEXAS



LEGEND:

BASIN BOUNDARY

FIGURE II-8
SURFACE GEOLOGY
COLORADO RIVER BASIN



SOURCE: Bureau of Economic Geology, The University of Texas, Geologic Map of Texas, 1933.

of the Llano Uplift and intrusive rocks are exposed in and contiguous to the Balcones fault zone. Sedimentary formations of the Cambrian, Ordovician, Pennsylvanian, Permian and Triassic systems outcrop in the Central Texas Section. Cretaceous (Comanche series) formations control the Edwards Plateau, while the Gulf Coastal Plain is comprised of Cretaceous (Gulf series), Eocene, Pliocene, Miocene, Oligocene and Quaternary formations.

Lithologically, the various formations include a variety of rock types. Beginning with the oldest and progressing to the youngest, the composition of the formation is as follows: Pre-Cambrian-granite, schist, gneiss, conglomerate and sand; Cambrian and Ordovician-sandstone, conglomerate, limestone, dolomite and shale; Silurian-predominately limestone; Devonian-sandstone, chalk, marl and limestone; Mississippian-marl, shale and limestone; Pennsylvanian- chiefly shales, limestone and lesser amounts of sandstone; Permian-primarily shales, limestones, sandstones, dolomites, gypsum, anhydrite and some salt; Triassic and Jurassic-basically sandstone, shale, salt, limestone, anhydrite, chalk and some conglomerate; Cretaceous - primarily limestones, sandstones, sands, shales, chalk and marls; and Eocene, Oligocene, Miocene, Pliocene and Quaternary-usually less consolidated than later formations and for the most part, consist of varying portions of clay, silt, marl, sand, gravel, lignite, bentonite, shells, concretions, soft sandstones and clay-shales. A cross-section through the axis of the Basin, as shown in Plate II-1, illustrates the noted lithography.

Structurally, the various geologic systems in the Basin reflect considerable crustal movements, such as faulting, uplifting and downwarping. The Balcones fault zone, which crosses the Colorado River near Austin, has resulted in rock displacements of several hundred feet. This action accounts for the prominent escarpment between the Edwards Plateau and the Gulf Coastal Plain. As a result of the various crustal movements, the regional dip of the area upstream of the Llano Uplift is to the northwest, resulting in the successively older formations encountered as the Colorado River progresses from its headwater to the Uplift. Downstream of the Uplift, the dip of the Cretaceous and younger beds is to the southeast.

Land Use.

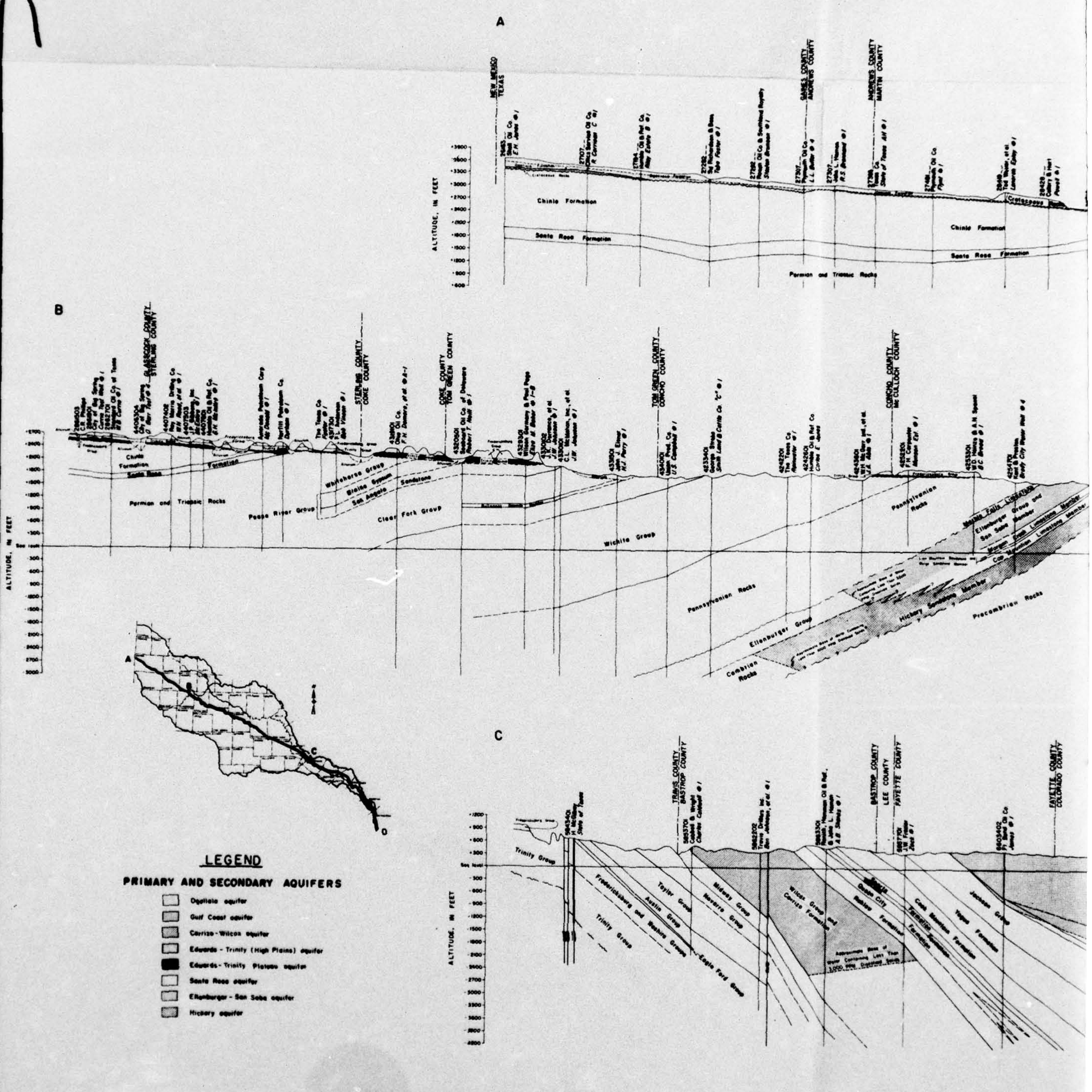
The predominant usage of land in the Colorado River Basin is for agricultural and ranching purposes. Approximately 60 percent of the land in the Basin is range and unimproved pastureland utilized in the production

of cattle, sheep, and goats. This land demands little in the way of water or intensive care, and is quite inefficient in terms of animal unit production per acre. It is generally covered with mesquite, chaparral, or scrub oak, and may require ten to twelve acres to support one cow. In contrast, good grassland requires only one to two acres for the same support.

Farming, in a broad sense, occupies another 30 to 35 percent of the land area in the Basin. This may range from subsistence farming in the central Basin to large-scale production of sorghum on the high plains or rice on the Coast. In many cases, especially in the more arid upper reaches of the Basin, the scale and intensity of cultivation is limited by the availability of water for irrigation. In the upper and central regions of the Basin, only about 10 to 20 percent of the potentially irrigable land is presently under irrigation. Most of the irrigation water for these regions is pumped from continually decreasing ground water reserves. The Texas Water Development Board predicts severe production limitations or shifts in crop types resulting from water shortages if some supplemental water source is not soon developed. The lower Basin is presently being irrigated primarily for rice production. Annual surpluses of surface water in this area seem adequate for future irrigation needs.

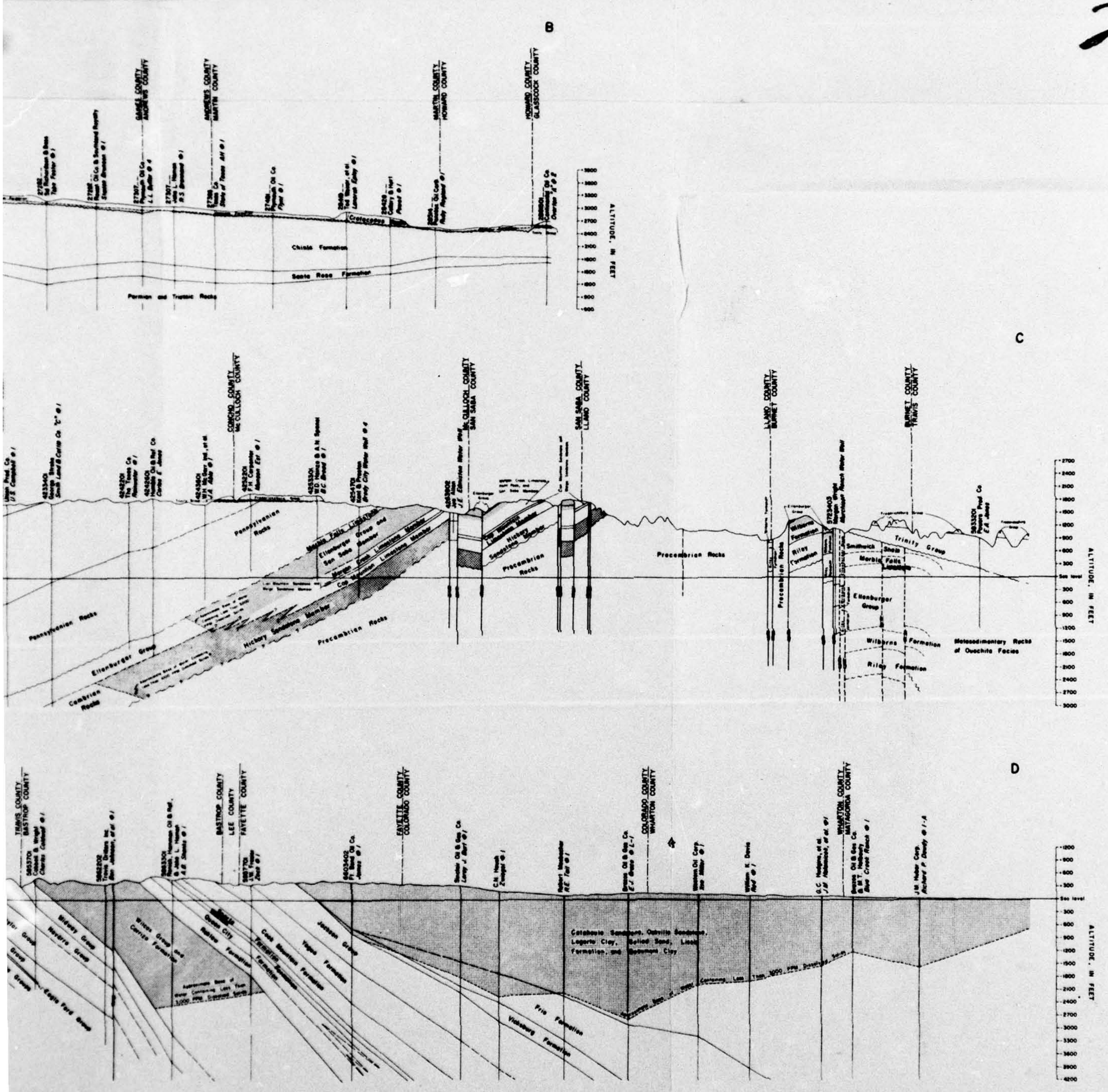
For the purposes of this study, Basin land-use description was restricted to those forms of usage that had direct relation to accomplishable results in a Wastewater Management Study. For a 40, 000-square-mile area, it was of concern what would be the ultimate result of the delineation of specific land-use tracts. With concern for encouraging substitution of effluent for irrigation water presently drawn from surface or ground water supplies, The Governor's Office, Division of Planning Coordination furnished the locations and permit requirements of all permitted irrigation tracts in the Basin. This irrigated land is shown in Plate II-2.

The main non-agricultural industries in the Basin are related to petroleum production. Oil and gas fields are scattered over approximately half of the Basin, but are mostly concentrated in the upper and lower reaches. Much of the land in the oil-producing regions is also used concurrently for agricultural purposes. However, the additional petroleum resource has brought a different expression to the traditionally rural face of the land. Population concentrations have developed at Midland, Odessa, and Big Spring to service and supply the oil production complexes.



SOURCE: ADAPTED FROM TEXAS WATER DEVELOPMENT BOARD. Reconnaissance Investigation of the Ground - Water Resources of the Colorado River Basin, Report 51, July 1967.

2



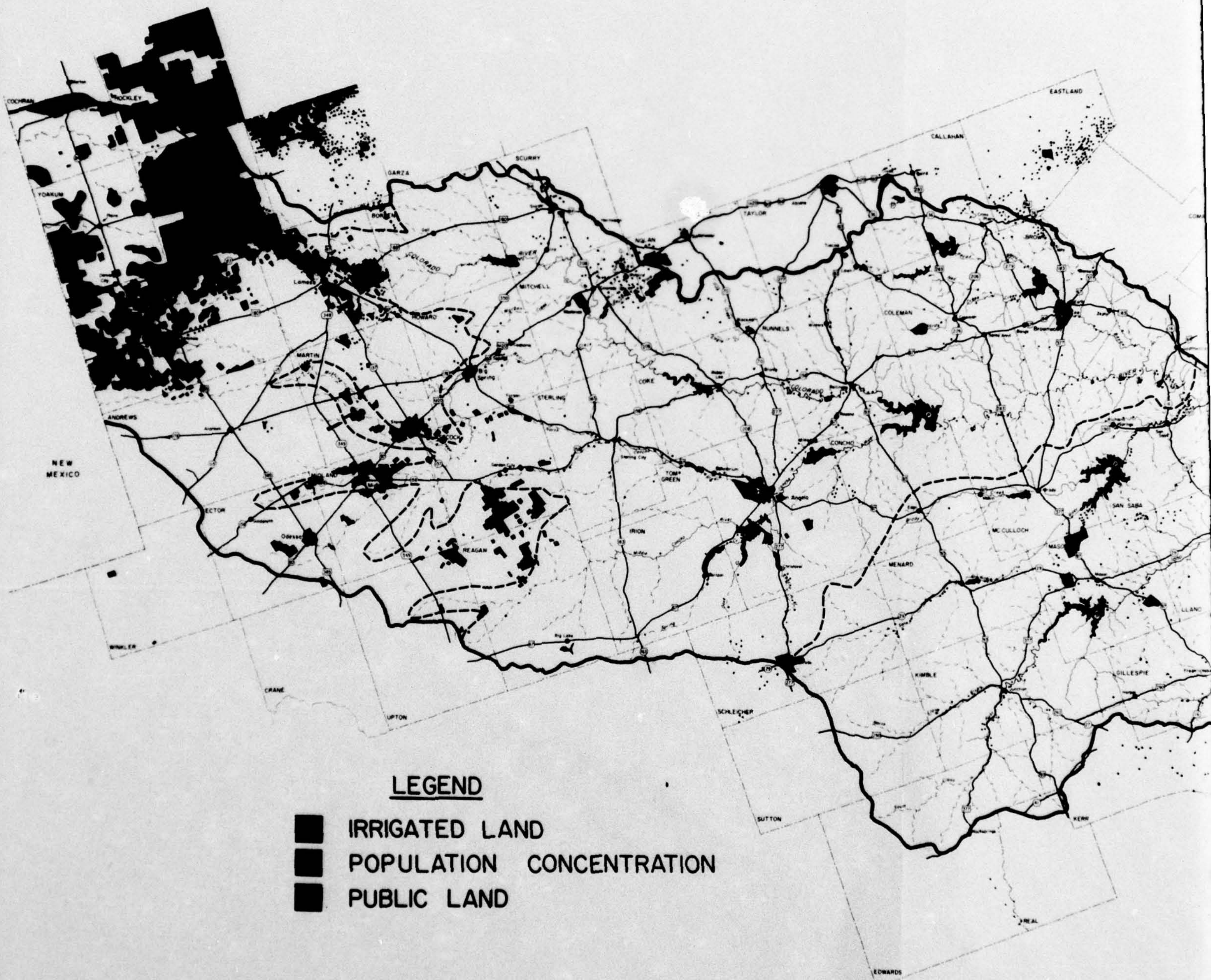
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

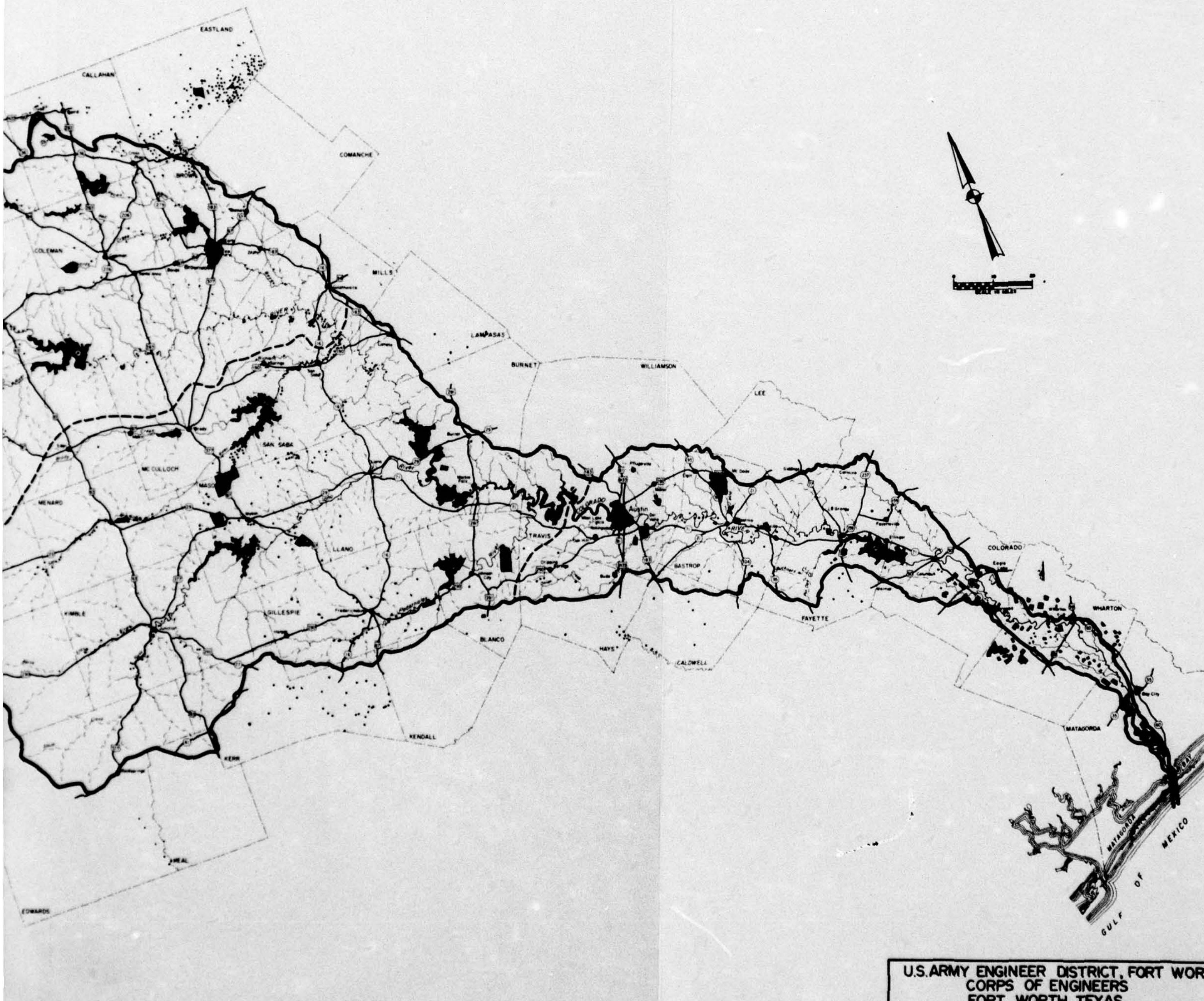
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

GEOLOGIC SECTION ALONG AXIS
OF COLORADO RIVER BASIN

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 18 MILES	PLATE II-1


COCHRAN
HOCKLEY
YOAKUM
GARZA
SCURRY
EASTLAND
CALLAHAN
TAYLOR
COLEMAN
RUNNELS
MITCHELL
MARTIN
ANDREWS
STERLING
COKE
CONCHO
TOM GREEN
IRION
REAGAN
ECTOR
NEW MEXICO
McCULLOCH
SAN SABA
MENARD
KIMBLE
GILLESPIE
SCHLEICHER
SUTTON
CRANE
UPTON
WINKLER
EDWARDS
REAL
KERR
LEGEND
IRRIGATED LAND
POPULATION CONCENTRATION
PUBLIC LAND



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

BASIN LAND USE

TURNER COLLIE AND BRADEN, INC.-HOUSTON / PORT ARTHUR

SCALE: 1" = 34 MI. PLATE: II - 2

Population concentrations such as those servicing the oil industry have exerted demands on the area's water resources, often creating seasonal shortages and quality problems. In addition, related industrial growth has often occurred adjacent to the petroleum production concentrations and has created additional demands on the water resources.

Intense oil field activity and associated industries have caused special industrial waste problems in local surface and ground water resources. An example of this is contamination of surface water by oil field brines, particularly in the upper portion of the Basin. These brines are believed to be the cause of high total dissolved solids, chloride, and sulfate concentrations. With increasing use of such brines in secondary recovery, ground water contamination is also becoming a serious consideration.

As a general rule, urban areas are significant as concentrated or point sources of waste. The waste volume is increased greatly due to the increase in population density. In addition, urban runoff often contains substances such as polymers and aromatic hydrocarbons which strongly resist natural degradation. Thus, metropolitan and industrial areas can increase local pollution problems. The locations of all significant population concentrations have also been depicted on Plate II-2. As can be seen graphically, the populated areas of the Basin appear almost insignificant in relation to the Basin as a whole.

With the exception of the metropolitan areas of Austin, Big Spring, Brownwood, Midland, Odessa, and San Angelo, the Basin in general has less than 20 persons per square mile. The agricultural central Basin contains less than 5 persons per square mile and the coastal regions contain about 40 persons per square mile.

Exclusive of public school land, the Basin contains a relatively small amount of public land. Much of this land is associated with reservoirs or State Parks (Plate II-2) and is used for recreational purposes. Throughout the Basin numerous tracts of land have fallen to the State General Land Office as a result of survey errors or other causes. While these tracts are technically public or State-owned land, there is nothing to distinguish the land from its surroundings. Therefore, although the locations of these acreages were available for the study, they are not presented herein as a distinct land use.

Coordination with Land Use Policies and Controls.

Under current Texas Law, there is limited statutory authority to coordinate land-use decisions. Generally, the power to enact land-use management ordinances has been delegated only to municipalities. Other local governments such as counties, councils of government, and special-purpose districts have only indirect land-use control powers.

At the State level, the Texas Water Quality Board, the General Land Office and the School Land Board have statutory authority to consider land use in formulating policy or in exercising control of activities within their respective jurisdiction. The Texas Water Quality Board may consider land use in determining whether or not to issue certificates of registration to applicants for solid waste disposal sites. (Under the Texas Solid Waste Disposal Act, certain types of industrial wastes that are liquid are classified as industrial solid waste.) The Commissioner of the General Land Office is charged with the responsibility of establishing and enforcing management policies governing administration of State-owned lands. Under authority of recently enacted legislation, the School Land Board is commissioned to develop a continuing comprehensive coastal public lands management program to comply with the Federal Coastal Zone Management Act of 1972.

Although various State and local entities are empowered to exercise limited land-use controls, no system exists for the formal review of land-use decisions which affect the vast majority of Texas lands. Therefore, any influence upon this system must be exercised in an indirect and informal manner rather than through a classical zoning-type decisions process.

One method that the Board has previously utilized to influence the density of development, though not the specific use of the land, is the promulgation of Board orders regulating private sewage facilities (septic tanks). To date, twenty such orders have been issued pursuant to Article 21.083 Texas Water Quality Act. Another four county orders have been approved by resolution of the Board in accordance with Article 21.084 Texas Water Quality Act. Generally, the orders cover areas where the extensive use of private sewage facilities pose water pollution threats, such as near reservoirs and coastal areas. The orders influence land-use decisions through the provision that a parcel of land must be of minimum size (usually 10,000 - 20,000 sq. ft.) to be approved for private sewage facilities. In effect, minimum lot-size provision sets a maximum residential density and can tend to limit commercial and industrial facilities utilizing private sewage facilities.

It should be noted, however, that the minimum lot-size provision applies only to those parcels which are utilizing private sewage facilities. Where organized sewage systems exist, the discharge permit system regulates to some degree the optimum population by not allowing construction of treatment facilities unless such facilities meet adequate design construction standards, which include discharge requirements compatible with stream standards and ground water protection regulations.

Another, as yet untested, provision of the Texas Water Quality Act may allow the Texas Water Quality Board broad powers to influence the use of land if such a use would be detrimental to water quality. Article 21.092 reads:

> "Whenever the Board determines that the quality of water in an area is adversely affected or threatened by the combined effects of several relatively small-quantity discharges of wastes being made for which it is not practical to issue individual permits, <u>or that the general nature of a particular type activity</u> which produces a waste discharge is such that requiring individual permits is unnecessarily burdensome both to the waste discharger and the Board, the Board may, by rule, regulate and set the requirements and conditions for the dischargers of waste." (emphasis added)

While Article 21.092 has not, in the past, been utilized to influence land-use decisions so as to complement water quality goals, there is the possibility that it could be so used in the future. One area where use of the provisions of this article may be particularly appropriate is in the control of nonpoint pollution from urban or agricultural runoff.

It is the intent of the Texas Water Quality Board to utilize its existing statutory powers to influence land-use decisions to the extent possible so as to provide for the achievement of water quality goals. The Board will also work with other levels of government and other agencies of government to point out where their statutory power can be utilized to help influence land-use decisions to coordinate with and complement water quality enhancement actions.

The Board also recognizes that there are non-statutory methods of influencing land-use decisions. One such method is through the selection of sites for major public facilities such as parks, highways, reservoirs, etc.

The Texas Water Quality Board, as a member of the Interagency Council on Natural Resources, has direct contact with other State agencies whose activities can influence the use of land in this manner. This Board also reviews and furnishes comments on Draft Environmental Impact Statements prepared by local, State and Federal agencies. Additionally, the Board conducts A-95 and A-85 review of local, State, and Federal projects.

It is the intent of the Texas Water Quality Board to utilize these existing channels of communication and influence to point out where individual proposals can be directed to help achieve water quality goals. The Board will also point out where proposed actions will likely result in land-use patterns which would inhibit the realization of water quality goals.

To assure that land-use relationships were given proper consideration in the development of this plan, all available land-use plans and inventories within the Basin were reviewed. (A complete listing of all plans which were reviewed can be found in Volume 3, Section V.) Land uses, which could significantly affect instream water quality, were delineated and taken into account as stream segment classifications and waste load allocations were derived.

As future land use studies are performed in the Basin, they will be reviewed to determine their anticipated impact upon water quality. Should an adverse impact be expected, the authors of the study will be contacted and alerted to the expected impact of their proposal. If some alternate proposal cannot be derived, or if the study indicates an already changed land use (i. e. if the study is an existing land use survey), the changes will be noted and taken into account at the next Basin plan update.

Environmental Considerations.

Existing legislation pertaining to the environmental elements related to any Federally-funded construction effort requires an evaluation of all facets of the "total environment." Since the level of design associated with this study is the "conceptual" design level, the alternative presented herein are not site specific, with the exception of those alternatives that recommend expansion and/or modification of an existing sewage treatment plant. During the advanced engineering and design stage, potential sites for wastewater treatment facilities will be selected. At this time,

each potential site should be evaluated relative to possible impacts, either adverse or beneficial, and this analysis utilized for selection of the final recommended site. Therefore, one purpose of Sections II, III, IV, and V of this Volume is to present an overview of those environmental elements and conditions that exist within the Colorado River Basin.

Botanical Elements.

The Colorado River crosses eight vegetative zones (Figure II-9). From east to west these zones are: Southern High Plains, Rolling Plains and Prairies; Edwards Plateau; West Cross Timbers; Grand Prairie; Blackland Prairie; Post Oak; and Coastal Prairies. A listing of the predominant vegetation is presented for each of the eight vegetative zones.

Zone 1 - Southern High Plains.
(Gaines, Yoakum, Terry, Dawson, Martin and Andrews Counties)

The five vegetative types recognized within Zone 1 are: mesquite-shortgrass high plains; high plains cultivated uplands; shinnery oak dominant uplands; juniper dominant uplands; and mesquite-shortgrass uplands.

1. Mesquite-shortgrass high plains support;

a. Woody plants.

Low mesquite (Prosopis juliflora)
Lotebush (Condalia obtusifolia)
Catclaw (Acacia greggi)
Junipers
Shinnery oak (Quercus spp.)

b. Grasses.

Sand dropseed (Sporobolus cryptandrus)
Buffalograss (Buchloe dactyloides)
Side-oats grama (Bouteloua curtipendula)
Silver bluestem (Andropogon saccaroides)
Plains bristlegrass (Setaria macrostachya)
Western wheatgrass (Agropyron smithii)

2. High plains cultivated uplands support:

a. Woody plants.

Low shinnery oak
Chinese elm
Hackberry

b. Cultivated plants..

Grain sorghums
Cotton
Variety of small grains

3. Shinnery oak dominant uplands support primarily a band of shinnery oak.

4. Juniper dominant uplands support primarily juniper with little other vegetation types represented.

5. Mesquite - short grass uplands support:

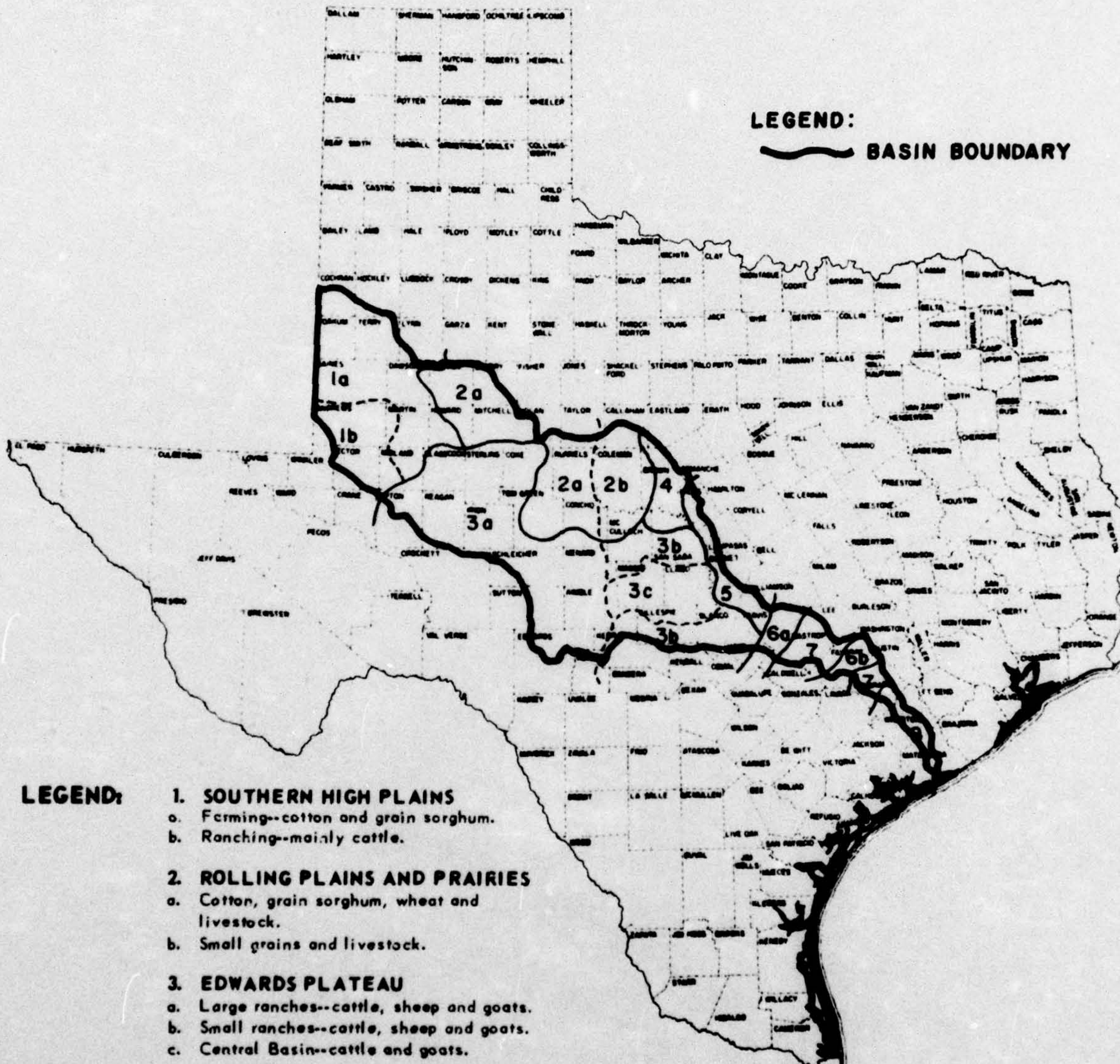
a. Woody plants.

Mesquite
Lotebush
Creosote bush (*Larrea divaricata*)
Prickly pear cactus (*Opuntia macrohiza*)
Chinaberry trees (*Sapindus drummondi*)

b. Grasses.

Sand dropseed
Sideoats grama
Buffalograss
Silver bluestem

FIGURE II-9
AGRICULTURAL REGIONS
COLORADO RIVER BASIN



LEGEND:

1. **SOUTHERN HIGH PLAINS**
   a. Farming--cotton and grain sorghum.
   b. Ranching--mainly cattle.
2. **ROLLING PLAINS AND PRAIRIES**
   a. Cotton, grain sorghum, wheat and livestock.
   b. Small grains and livestock.
3. **EDWARDS PLATEAU**
   a. Large ranches--cattle, sheep and goats.
   b. Small ranches--cattle, sheep and goats.
   c. Central Basin--cattle and goats.
4. **WEST CROSS TIMBERS**
   a. Peanuts, dairy products and livestock.
5. **GRAND PRAIRIE**
   a. Small grains, cotton, dairy products and livestock.
   b. Livestock, small grains and cotton.
6. **BLACKLAND PRAIRIE**
   a. Cotton and livestock.
   b. Poultry, dairy products, cattle and cotton.
7. **POST OAK**
   a. Cotton and livestock.
8. **COASTAL PRAIRIE**
   a. Rice, cattle and dairy products.
   b. Cotton, rice and cattle.

SOURCE: Texas Agricultural Experiment Station, Types of Farming in Texas Bulletin 964, 1960.

Zone 2 - Rolling Plains and Prairies.
(Runnels, Coleman, Concho and Tom Green Counties)

The two main vegetative types recognized within Zone 2 are: mesquite-short grass uplands and mesquite dominant bottomlands.

1. Mesquite - short grass uplands support:

a. Woody plants.

Mesquite
Juniper
Catclaw
Algerita (*Berberis trifoliolata*)
Lotebush
Littleleaf sumac
Pricklypear and other cacti
Tasajillo (*Opuntia leptocaulis*)
Live oak
American elm (*Ulmus americana*)
Hackberry (*Celtis laevigota*)
Chinaberry (*Melia* sp.)
Pecan (*Carya illinoensis*)
Ephedra (*Ephedra antisyphiltica*)
Gum elastic (*Bumellia langinosa*)
Black persimmon
Black willow (Streambed associated)
Black walnut (Streambed associated)
Winged elm (Streambed associated)
Cottonwood (Streambed associated)
Prickly ash (Streambed associated)

b. Grasses.

Buffalograss
Sand dropseed
Sideoats grama
Tobosa (*Hilaria mutica*)
Threeawns
Curly mesquite (*Helaria belangeri*)
Hooded windmill grass
Vine mesquite
Texas wintergrass (*Stipa leucotrica*)
Sandbur (*Cenchrus* sp.)

2. Mesquite dominant bottomlands support:

a. Woody plants.

Mesquite
American elm
Hackberry
Saltcedar (*Tamarix gallica*)
Pecan
Lotebush
Catclaw
Algerita
Tasajillo
Black willow
Winged elm
Cottonwood

b. Cultivated crops.

Cotton
Grain sorghum
Small grains

c. Grasses.

Johnson grass (*Sorghum halepense*)
Bermudagrass (*Cynodon dactylon*)
Vine-mesquite (*Panicum obtusum*)
Plains bristlegrass (*Setaria macrostachya*)
Arizona cottontop (*Trichachne* sp.)
Switchgrass (*Panicum virgatum*)
Buffalograss
Sand dropseed
Rescuegrass (*Bromus catharticus*)
Sandbur
Little barley (*Hordeum pussillum*)

Zone 3 - Edwards Plateau.
(Sterling, Upton, Reagan, Irion, Coke, Menard, Schleicher, McCulloch, San Saba, Sutton, Kimble, Gillespie, Travis and Hays Counties)

The three vegetative types recognized within Zone 3 are: mesquite-short grass uplands; juniper - short grass uplands; and mesquite dominant bottomlands.

1. Mesquite - short grass uplands support:

a. Woody plants.

Mesquite
Lotebush
Algerita
Sagebrush
Chinaberry
Hackberry
Juniper
Catclaw
Live oak
American elm
Creosote bush
Tarbush
Fourwing saltbush (*Atriplex conescens*)
Javelina brush (*Microrhammus ericoides*)
Allthorn (*Koeberlinia spinosa*)

b. Grasses.

Buffalograss
Sideoats grama
Silver bluestem
Plains bristlegrass
Sand dropseed
Prairie threeawn (*Aristida oligantha*)
Tobosa grass
blue grama
black grama
Hooded windmillgrass
Sand bluestem

2. Juniper - short grass uplands support:

a. Woody plants.

Juniper
Lotebush
Tasajillo
Algerita
Liveoak

Pecan
Hackberry
Elm
Mohrs shin oak (<u>Quercus</u> <u>mohriana</u>)
American elm

b. <u>Grasses.</u>

Silver bluestem
Buffalograss
Sideoats grama
Threeawns

3. Mesquite Dominant Bottomlands support:

a. <u>Woody plants.</u>

Mesquite
Pecan
American elm
Hackberry
Live oak
Cottonwood
Saltcedar (<u>Tamarix</u> <u>gallica</u>)
Lotebush
Fourwing salt bush
Algerita

b. <u>Grasses.</u>

Johnsongrass (<u>Sorghum</u> <u>halapense</u>)
Bermudagrass (<u>Cynodon</u> <u>dactylon</u>)
Vine-mesquite
Plains bristlegrass (<u>Setaria</u> <u>macrostachya</u>)
Arizona cottontop (<u>Trichachne</u> <u>californica</u>)
Switchgrass

<u>Zone 4 - West Cross Timbers.</u>
(Mills, Brown, and Eastland Counties)

a. <u>Woody plants.</u>

Post oak
Blackjack oak

b. Grasses.

Little bluestem
Big bluestem
Indiangrass
Switchgrass
Canadian wildrye (Elymus canadensis)
Sideoats grama
Hairy grama
Tall dropseed
Texas wintergrass

Zone 5 - Grand Prairie.
(Brown, Mills, Lampasas, Burnet and Travis Counties)

a. Woody plants.

Liveoak
Juniper
Mesquite
Elm
Texas oak
Hackberry
Shinoak
Mustang grape
Muscadine grape
Catclaw
Whitebrush
Algerita
Texas persimmon
Elbow bush
Flameleaf sumac
Black willow
Prickly ash
Potatoe Chip Ash

b. Grasses.

Threeawns
Texas wintergrass
Little bluestem
Silver bluestem

Johnsongrass
Bermudagrass
Texas grama
Sideoats grama
Feathery bluestem
Seep muhly
Buffalograss
Curly mesquite
Hairy grama

c. Forbes.

Prairie coneflower
Orange zexmania
Antelopehorn milkweed
Hoarhound
Ragweed
Englemann daisy
Broomweed
Croton
Canada thistle
Daisy fleabone
Queens delight
Sunflower
Narrowleaf bitterweed
Seep willow
Prickly pear
Yucca
Silverleaf nightshade

Zone 6 - Blackland Prairie.
(Travis, Bastrop, Fayette and Colorado Counties)

a. Woody plants.

Mesquite
Southern pricklyash (Zanthoxylum clava-herculis)
Hackberry
Bois d'Arc (Maclura pomifera)
Black willow
Pecan
Elm
Hickory
Walnut

b. Grasses.

Threeawn
Buffalograss
Brownseed paspalum (Paspalum plicatulum)
Lovegrasses (Eragrostis spp.)
Silver bluestem
Bermudagrass
Johnsongrass
Texas wintergrass
Dallisgrass

c. Forbes.

Croton
Sunflower
Prairie coneflower
Ragweed
Rough march elder
Narrowleaf bitterweed
Silverleaf nightshade

Zone 7 - Post Oak Savannah.
(Bastrop, Fayette and Colorado Counties)

The four vegetative types recognized within Zone 7 are: bottomland; upland hardwood; upland hardwood cedar; and upland piney hardwood-cedar.

a. Woody plants.

(1) Bottomland.

Pecan
Cottonwood
Sycamore (Plantanus occidentalis)
Black willow
Water elm
Hackberry
Liveoak

(2) Upland Hardwoods.

Post oak (Quercus stellata)
Blackjack oak (Quercus marilandica)
Yaupon (Ilex vomitoria)
Deciduous holly (Ilex decidua)
Mockernut hickory (Carya tomentosa)
American beautyberry
Prickly ash
Mesquite
Gum elastic

(3) Upland Hardwood-cedar.

Post oak
Blackjack oak
Eastern redcedar (Juniperus virginiana)
Water oak (quercus nigra)
Water elm (Planera aquatica)
Mesquite
Yaupon
Deciduous holly
American beautyberry
Live oak
Woolly bucket
Huckleberry
Haws

(4) Upland Piney Hardwood-Cedar.

Loblolly pine (Pinus taeda)
Post oak
Blackjack oak
Eastern redcedar
Yaupon
Deciduous holly
American beautyberry
Farkleberry (Vaccinium arboreum)

b. Grasses.

(1) Bottomland.

Bermudagrass (Cynodon dactylor)
Texas wintergrass (Stipa leucotricha)
Rescuegrass (Bromus unioloides)
Florida paspalum (Paspalum floridanum)
Brownseed paspalum
Little bluestem

(2) Upland Hardwoods.

Threeawns (Aristida spp.)
Little bluestem
Silver bluestem
Brownseed paspalum
Low panicums
Tall dropseed
Gramas
Buffalograss
Red lovegrass
Broomsedge bluestem

(3) Upland hardwood-cedar

Texas wintergrass
Buffalograss
Threeawns
Switchgrass
Little bluestem
Brownseed paspalum
Purple lovegrass (Eragrostis spectabilis)

(4) Upland piney hardwood-cedar

Little bluestem
Wright's threeawn (Aristida wrightii)
Switchgrass
Panicums

Zone 8 - Coastal Prairie.

a. Woody Plants.

Mesquite
Oaks
Acacias
Pricklypear

b. Grasses.

Big bluestem (*Andropogon gerardi*)
Seacoast bluestem (*Schizachrium scoparium* var. *Zitteralis*)
Indiangrass
Eastern gamagrass (*Tripsacum dactyloides*)
Gulf muhly (*Muhlenbergia capillaris* var. *filipes*)
Panicums
Yankeeweed
Broomsedge bluestem
Smutgrass
Bermudagrass
Carpetgrass

c. Forbes.

Western ragweed (*Ambrosia psilostachya*)
Tumblegrass (*Schedonnardus paniculatus*)

Rare and Endangered Plant Species.

Rare and endangered plant species in the Colorado River Basin are listed below in the following table and in the zone in which the highest probability of their occurrence exists:

Woody Plants	Area
Leadplant	Coastal Prairie
Texas Madrone	Edwards Plateau
Shadscale Saltbrush	Rolling Plains
Southwestern Rabbitbrush	Rolling and High Plains
Narrowleaf Forestiera	Coastal Prairie
Wild Roses	Several Zones

Grasses	Area
Big Bluestem	Coastal Prairie
New Mexico Bluestem	High and Rolling Plains
Canada and Virginia Wildrye	Several Zones
Sandhill Lovegrass	Post Oak
Texas Fescue	Edwards Plateau
Junegrass	High Plains
Harvard Panicum	High Plains
Yellow Indiangrass	Several Zones
Big Cordgrass	Coastal Prairie
Smooth Cordgrass	Coastal Prairie
Prairie Cordgrass	Coastal Prairie
Crinkleawn	Coastal Prairie
Sea Oats	Coastal Prairie

Forbes	Area
Button Snakeroot	Blackland Prairie and Post Oak
Vigna Luteola (genus Cow-peas)	Coastal Prairie
Cardinal flower	Near streams and swamps (Coastal Prairie)

Zoological Elements.

Mammals.

The Colorado River Basin provides suitable habitat for approximately 30 different species of animals. A listing of those species of economic importance are presented, by county of known range, in Table 2-A. The column heading "furbearers" includes, but is not limited to, rabbits, raccoons, oppossums, mink, foxes, coyotes, bobcat, and ring-tailed cats. The column heading "deer" includes only whitetail deer, the State's most abundant game species. Mule deer are found mainly in the far west reaches of the Basin.

TABLE 2-A
WILDLIFE

Vegetative Zone	County	Deer	Javelina	Antelope	Furbearers	Squirrel	Quail	Turkey	Dove
1. Southern High Plains	Gaines			X	X	X	X		
	Yoakum			X	X	X	X		
	Terry			X	X	X	X		
	Dawson	X		X	X	X	X	X	
	Martin				X	X	X		
	Andrews			X	X	X	X		
2. Rolling Plains and Prairies	Runnels				X		X	X	X
	Concho	X					X	X	
	Tom Green	X			X		X	X	X
3. Edwards Plateau	Sterling	X		X	X	X	X	X	
	Upton	X	X		X		X	X	
	Reagan								
	Irion	X		X	X	X	X	X	
	Coke	X							
	Menard	X					X	X	
	Schleicher	X	X				X	X	X
	McCulloch	X					X	X	
	San Saba	X			X		X	X	X
	Sutton								
	Kimble	X					X	X	X
	Gillespie								
	Travis	X					X	X	X
	Hays	X					X	X	X
4. West Cross Timbers	Mills	X			X	X		X	
	Brown	X			X	X		X	
	Eastland	X			X	X		X	
5. Grand Prairie	Brown								
	Mills								
	Lampasas								
	Burnet	X			X		X	X	X
	Travis	X					X	X	X
6. Blackland Prairie	Bastrop	X			X		X		X
	Travis						X	X	X
	Fayette	X			X	X	X		X
	Colorado								
7. Post Oak Savannah	Bastrop	X			X	X	X	X	X
	Fayette	X			X	X	X		X
	Colorado								
8. Coastal Prairie	Wharton	X			X	X			
	Matagorda	X			X	X			

Rare and endangered mammal whose known range includes portions of the Colorado River Basin are: river otter, Texas red wolf, black-footed ferret, and rare (in Texas) silver-haired bat. Peripheral mammals include: coatimundi, jaguarundi, and ocelot.

Fish.

Fish in the Colorado River are a diversified resource. Although perennial streamflow is existent in very few reaches of streams within the Basin, the presence of deep pools in many cases permits the maintenance of fish population during periods of no or low flow. In the Basin, many so-called ephemeral streams actually have subsurface flows which nourish the remaining pool areas and therefore provide excellent fishery habitat during drouth periods.

The Colorado is a stream fed by many tributaries which flow through semi-arid country. Some of the tributaries popular for fishing are the three branches of the Concho, which converge near San Angelo. The San Saba River is also a popular fishing area. Further downstream, the Llano River brings in additional water from the limestone and granite country of Central West Texas. This spring-fed river is a favorite of many Texans. These waters abound with black bass and catfish. The Colorado River is well known for its largemouth bass, spotted bass, channel catfish, flathead catfish, and sunfish. The Colorado River has also recently been stocked with striped bass and walleye, and these fish are expected in the future to add significantly to the already good stream fishing.

Many lakes have been built in the Colorado River Basin, including E. V. Spence, San Angelo, Town, Austin, Travis, Marble Falls, etc. These waters offer fishing for largemouth bass, channel catfish, flathead catfish, and sunfish. Fishing for white bass and crappie is seasonally good. But, like most man-made lakes, in three to five years after filling, their fish populations are dominated by less desirable fishes.

It is debatable whether production is greater in a reservoir habitat as compared to a stream system, but it is known that the production in reservoirs is largely in fishes at the bottom of the food web (rough and forage fishes).

This fish community structure does not occur in cleaner streams of the Basin ("clean" meaning streams with rocky and organic sediment substances rather than sand or inorganic silt bottoms). The sport-rough fish structures are fairly proportional to one another. In other words, these streams maintain much better quality fisheries than do the Basin's lakes.

The Colorado River empties into the Gulf which contains red drum, black drum, flounder, spotted seatrout, gafftopsail catfish, salt-water sheepshead, croaker, mullet, menhaden, oysters, blue crab, and shrimp. The lower reach of the Colorado River is tidal and also supports populations of fish and crustaceans similar to that of Matagorda Bay.

Unusual fish include the bowfin or dogfish, a cylindrically-shaped survivor of a primitive fish group. This fish has been observed as far west as the Colorado River below Austin and can be considered a relic from the past. Included in the tentative draft of "Rare and Endangered Texas Fishes," furnished by the Texas Academy of Science, are three fishes found within the Colorado River Basin. These fishes are the Guadalupe bass (*Micropterus treculi*), the suckermouth minnow (*Phenacobius mirabilis*), and the Clear Creek gambusia (*Gambusia heterochir*).

There have been instances of fish kills in the Colorado River, with one of the most lethal occurring in 1961. In this instance, insecticide was accidentally discharged into the river near Austin. The insecticide took its toll on fish, crustaceans, and plant life downstream of the spill. The locks on the Intracoastal Waterway were closed to divert the toxic river water into the Gulf of Mexico and away from the oyster and shrimp grounds in Matagorda Bay. Later, seine tests to determine the extent of the fish kill failed to obtain any live fish.

Birds.

Birds within the Colorado River Basin are also a diversified resource. Of significance are the estimated 500,000 waterfowl that annually pass through the Basin on their migration routes. Included are mallard, pintail, shoveler, lesser scaup, baldpate, blue winged and green winged teal, gadwall, snow goose, blue goose, white-fronted goose, Canada goose, and coot. Nesting grounds of wood duck have been observed along wooded streams as far north as Menard County. Mottled ducks, fulvous tree ducks, and black-bellied ducks nest in the coastal rice fields and marshes.

The known range of many rare and endangered species extends to portions of the Colorado River Basin. A listing of some of these species includes: short-tailed hawk, southern bald eagle, prairie falcon, American peregrine falcon, Attwater's prairie chicken, lesser prairie chicken, whooping crane, greater sandhill crane, American ivory-billed woodpecker, and the northern red-cockaded woodpecker. Of particular environmental concern is the special habitat requirements of the rare golden-cheeked warbler found in portions of nine counties in the Colorado River Basin. This rare bird, with an extremely limited habitat, builds its nests solely out of long strips of bark of the Ash Juniper tree. Extensive land clearing has jeopardized this exclusive habitat of the golden-cheeked warbler and various interested parties have brought the matter before public officials and private landowners in an effort to preserve this colorful and unique specie in Texas.

Reptiles and Amphibians.

Reptiles and amphibians are also numerous within the Basin. Poisonous snakes include the rattlesnake, copperhead, water moccasin, and the uncommon coral snake. Included in the rare or endangered species listing are the American alligator, Houston toad, and the Texas blind salamander. A remnant population of alligators is found in Hays and Colorado Counties.

Archeological, Historical and Cultural Elements.

Land in the State of Texas has an unusually high density of archeological and historical resources. Evidences of aboriginal cultures are evident in every county. The Colorado River Basin has not yet been comprehensively surveyed and studied for archelogical and historical sites. However, it has in the past yielded evidence of highly significant prehistoric and historic sites, ranging from the Archiac, through Neo-American Stages and on up into the early Anglo-American settlement stage of cultural development.

The nearly 1300 known archelogical sites in the Colorado River Basin are non-renewable resources whose value has to be conscientiously weighed before allowing them to be subjected to any possible loss. Some have already been irretrievably destroyed either by uninformed people or by construction. The archelogical sites in the Basin are predominantly found near streams or rivers, indicating that the early inhabitants in the territory--that would later be designated as the Colorado River Basin--

lived near the life-sustaining water resources. Archelogical findings show that man has inhabited this area for the last 15,000 years, but archelogical sites are not comprehensive. Sites are restricted to those areas of historical significance close to urban centers, and many remote areas have yet to be investigated by archelogists for a better definition of earlier man, his culture and his historical impact on the Colorado River Basin.

During the evaluation of potential sites for a given wastewater treatment facility it should be determined what significant non-renewable cultural resources will be affected by such use, and what mitigative steps must be taken to protect this important segment of the State's cultural heritage.

Recreation.

In the development of this Basin Plan, a primary objective was to protect and enhance the quality of existing as well as proposed water resources, in order for the waters of the State to fulfill their designated uses. In designating the uses for the waters within the Basin, the State attempted to recognize present as well as practicable future uses and, where possible, provide for a variety of uses. As shown on Plate IV-1, the water uses designated for the Colorado River Basin include recreation as well as for fish and wildlife propagation.

In a discussion of the overall recreation potential of the Basin, equitable consideration should be given to a diversity of public recreational demands, not only to those demands associated with the familiar reservoir activities. The rivers, streams and bayous of the Colorado River Basin have received increased usage and recognition by recreationists in the past few years. On both a national and local level, there is increased demand by the public for areas that have retained their natural character and where more primitive (wilderness) experiences can be obtained. Recent increases in the sales and rentals of river-oriented recreation equipment tend to support observations of increased river usage for recreation purposes. The sales and rentals of canoes, kayaks and rafts has been on a spiralling uprise, and the recreational usage of the river for float trips and primitive camping has experienced a marked increase. Also, at least four commercial "float trip guides" have been published that recommend trips along waterways of the Colorado River Basin.

The Texas Parks and Wildlife Department has been engaged in a long-range study to determine the feasibility of establishing a Statewide system of waterways. During the course of this study, specific rivers and streams that have sufficient values for inclusion in such a system are being identified. Preliminary results of the study indicate that sections of the Colorado, Concho, Llano, Pedernales, and San Saba Rivers may have recreation potential sufficient to warrant inclusion in such a waterway system. Also, various State and local agencies are scrutinizing the water quality of reservoirs and flowing streams within the Basin with an eye as to the capability of these waters supporting their designated uses. Extensive investigations are currently in progress to establish the relationship of fresh water inflows into coastal waters and the attendant effects on the flora and fauna of the coastal areas. Results of these studies are very important, in view of the existing and projected boom of coastal recreational activities and the value of commercial fisheries.

Parks also play an important role in the recreational potential of the Basin. Eleven State parks and numerous local parks are found within the Colorado River Basin study area. Some concentration of park land use is noted in the Highland Lakes area, while other parks are on the banks of the Colorado River in Bastrop and Fayette Counties. The geographical location of these State parks is illustrated on Plate II-2.

Institutional Description.

Historically, water has been one of man's most valued natural resources, and due to its past history of ready availability in most areas, few regulations were placed upon its use until recent times. However, in the past several decades, the demands made upon this essential resource from both the industrial and municipal sectors have escalated at such a rate as to cause a growing concern for the protection and proper use of a supply that is not inexhaustible.

As a result of the realization that this natural resource must be conserved through pollution abatement measures and optimum development of water supplies, numerous agencies, bureaus, and offices have been established to institute and implement the measures necessary in effecting sound water resources programs. Each of these agencies, ranging from Federal to local in authority, addresses various aspects of the overall problem. Therefore, a myriad of institutions are involved in discussing institutional arrangements for any aspect of water resources management.

The following discussion presents a capsuled review of the institutional situation for the Colorado River Basin. This discussion will be directed specifically at State and local agencies (Figure II-10), as these form the basis for a viable implementation of the plan.

As seen in Figure II-11, there are a number of Federal agencies that have some interest in the water quality of the Basin. The primary agency would, of course, be the Environmental Protection Agency (EPA), the Executive Agency responsible for the protection of the nation's environment. EPA's numerous functions and responsibilities on the water forefront are largely attributed to the Federal Water Pollution Control Act and subsequent amendments. A much more comprehensive discussion of EPA's role and that of other Federal agencies is presented in the section entitled "Recommended Legislative, Institutional, and Jurisdictional Changes."

In Texas, there are three major State agencies concerned exclusively with water quality, development, regulation, administration, and management. These are the Texas Water Quality Board (TWQB), the Texas Water Development Board (TWDB), and the Texas Water Rights Commission (TWRC). In addition to these, there are several other State agencies whose functions also extend to water-related problems. The major State water agencies, together with this latter group of natural resources oriented agencies, coordinate their programs through the Interagency Council of Natural Resources and Environment, which is staffed by the Governor's office.

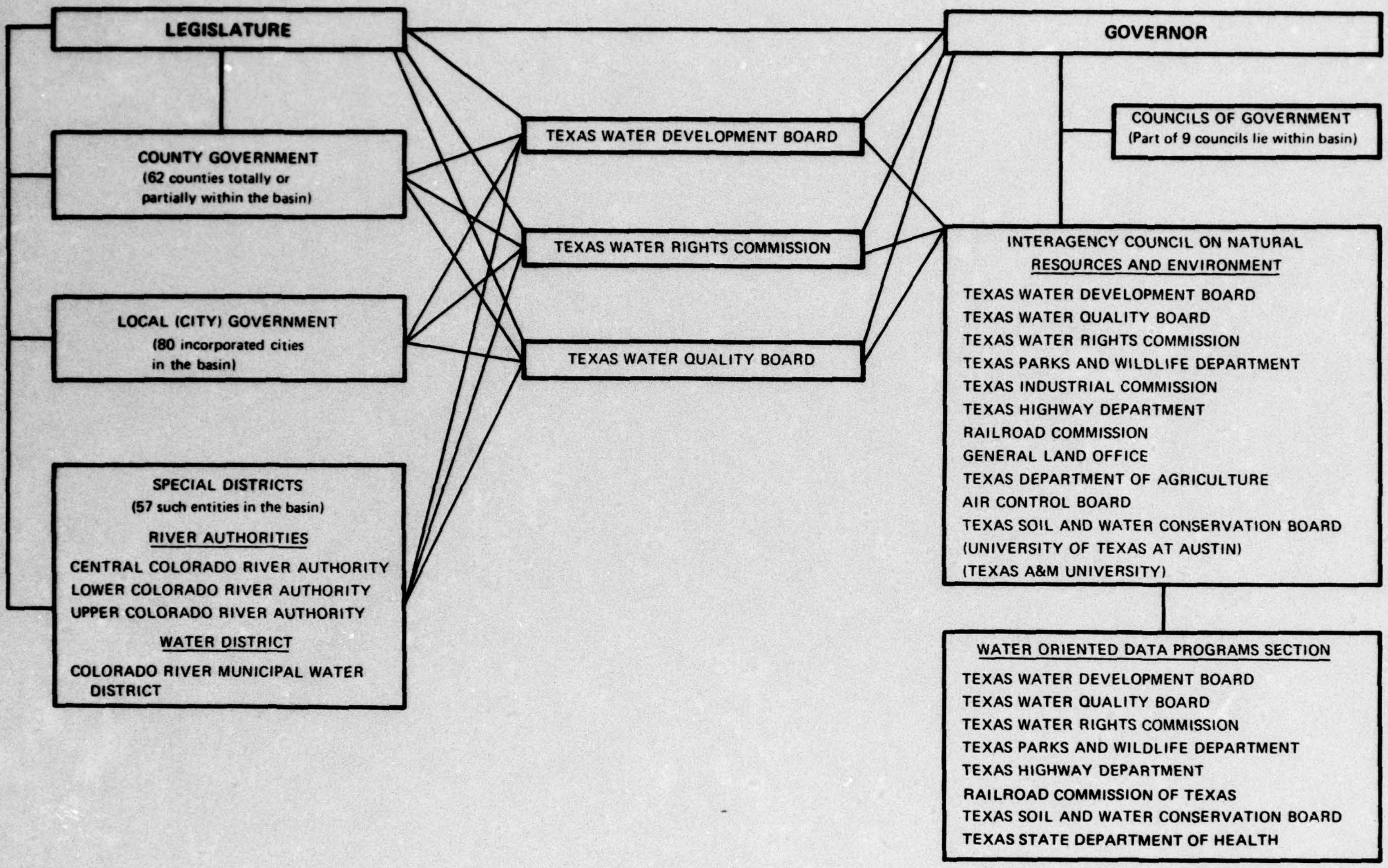
The functions and roles of the TWQB, TWDB, TWRC, and other State agencies whose interests involve water quality is presented below. Detailed explanations of these functions and roles are presented in Volume 4, Institutional Arrangements.

<u>Texas Water Quality Board.</u>

The Texas Water Quality Board was created by the Legislature under the Texas Water Quality Act of 1967 (which was revised by the 61st Legislature) as the successor to the Texas Water Pollution Control Board established in 1961. The TWQB is the principal authority in the State on matters relating to water quality within the State and is responsible for maintaining a water quality sampling and monitoring program for the State of Texas.

FIGURE II - 10

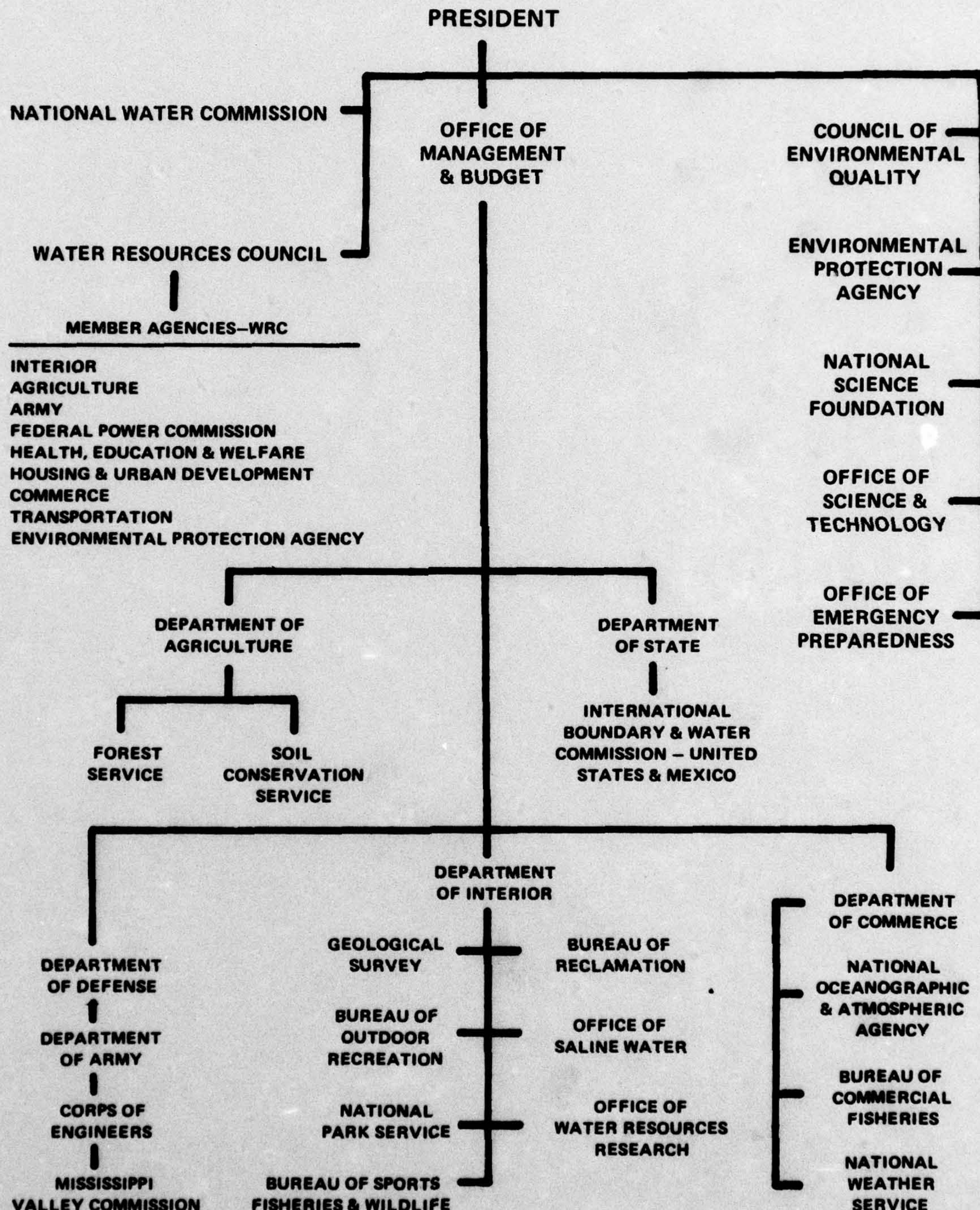
INSTITUTIONAL ARRANGEMENTS IN THE COLORADO RIVER BASIN



Source: Adapted from "Texas Water Development Board and Water for Texans" (February 1972)

FIGURE II - 11

SELECTED FEDERAL AGENCIES
INVOLVED IN WATER RESOURCES



Source: Adapted from "Texas Water Development Board and Water for Texans" (February 1972).

Basically, the Board's responsibilities are as follows: establish water quality criteria governing the discharge of wastes; conduct public hearings on all applications for said permits; regulate subsurface injection of wastes (other than wastes from oil and gas production); regulate industrial solid waste collection and disposal; conduct research and planning, both independently and in cooperation with other agencies, toward the goal of development of a comprehensive water quality control program throughout the State; make inspections and investigations necessary to enforce the rules and regulations of the Board; and has primary responsibility for the implementation of water quality management plans throughout the State.

In addition, the Board is also responsible for administering grants from the Environmental Protection Agency as well as funds appropriated by the Legislature for the planning and construction of wastewater collection and treatment facilities.

Texas Water Development Board.

This Board became an agency of the State of Texas by an amendment to the Constitution in 1957. Its initial purpose was to make loans to local governmental agencies sponsoring the construction of projects for the conservation and development of water resources in the State. Subsequent amendments, in 1962 and in 1966, broadened the Board's powers by authorizing it to acquire reservoirs and associated facilities to be constructed on Texas streams to the end that the remaining reservoir sites in Texas may be developed to their optimal potential. The Board may, by loan or by acquisition of interest, provide financial assistance to local governmental agencies for approved water projects consistent with overall planning objectives. Both the loan and the acquisition programs are designed to be ultimately self-liquidating, although the latter is not expected to acquire that status for many years. The administration of the Water Development Fund is governed by detailed statutory directives included in the Development Board Act.

Texas Water Rights Commission.

The primary role of the Texas Water Rights Commission is to regulate the use of Texas' public (surface) water to the end that it will be conserved and used for the greatest public benefit and in the public interest. In

order to fulfill this task, the Commission has been entrusted with broad discretion within certain statutory limits to grant or deny water permit applications, cancel existing appropriative water rights, adjudicate claims of water rights, collect data, and supervise various water districts and review their engineering projects financed with bonds. Further, the Water Rights Adjudication Act of 1967 requires the Commission to evaluate all uses of public water in the State, including permits and certified fillings as well as riparian and other previously unregulated rights. The Commission is currently in the process of adjudicating several streams in the State. (The Colorado River is one of the three rivers in the State which is currently over-allocated.)

Railroad Commission of Texas.

The Commission is the principal State regulatory agency for public utilities. As such, the Commission regulates the oil and gas industry and has the responsibility for prevention of surface and ground water pollution by oil or gas field practices.

Texas State Department of Health.

The Department's divisions of Sanitary Engineering and Waste Water Technology and Surveillance are primarily concerned with water quality matters. The two divisions' efforts extend to design, operation and maintenance of wastewater treatment facilities, monitoring the effluent from these facilities, stream monitoring for biological indicators such as coliform, as well as conducting the State solid waste (sanitary landfill) program, to mention only a few. The efforts of these two divisions have created a means whereby the Department can effectively assist communities to improve environmental conditions in urban and rural areas throughout the State.

Texas Parks and Wildlife Department.

Coincident with its primary role to protect, perpetuate, and improve the recreational and wildlife resources of the State, this agency enforces pollution laws affecting aquatic life and wildlife.

Division of Planning Coordination, Office of the Governor.

This Division evolved as a result of the Regional Planning Act of 1965. It is responsible for coordinating State-wide functional planning programs and administering the State grant program. Further, it is the State clearinghouse (ref. Office of Management and Budget Circular No. A-95) and consequently is empowered to review and comment on certain applications for Federal assistance. The Division has delineated a framework of twenty-one State Planning Regions to facilitate functional planning coordination throughout the State.

Moving from the broad jurisdictional responsibilities of the State agencies, regional entities are the next level in the institutional system. Regional councils and water districts are the primary entities included in this level of administrative authority.

Regional councils, more commonly referred to as "Councils of Governments" (COG), are functional planning organizations. Their jurisdictional boundaries usually coincide with those of the coincident State Planning Region. They are voluntarily-formed agencies composed of local governments, which serve as the coordinators of the various types of functional planning within their respective jurisdictional boundary. The Councils also serve as regional or metropolitan clearinghouses, and thus have the right to review and comment on applications for Federal grant assistance originating in or for their respective areas. The Basin encompasses part of the following nine Regional Councils:

Alamo Area Council of Governments
Capital Area Planning Council
Central Texas Council of Governments
Concho Valley Council of Governments
Houston-Galveston Area Council
Middle Rio Grande Development Council
Permian Basin Regional Planning Commission
South Plains Association of Governments
West Central Texas Council of Governments

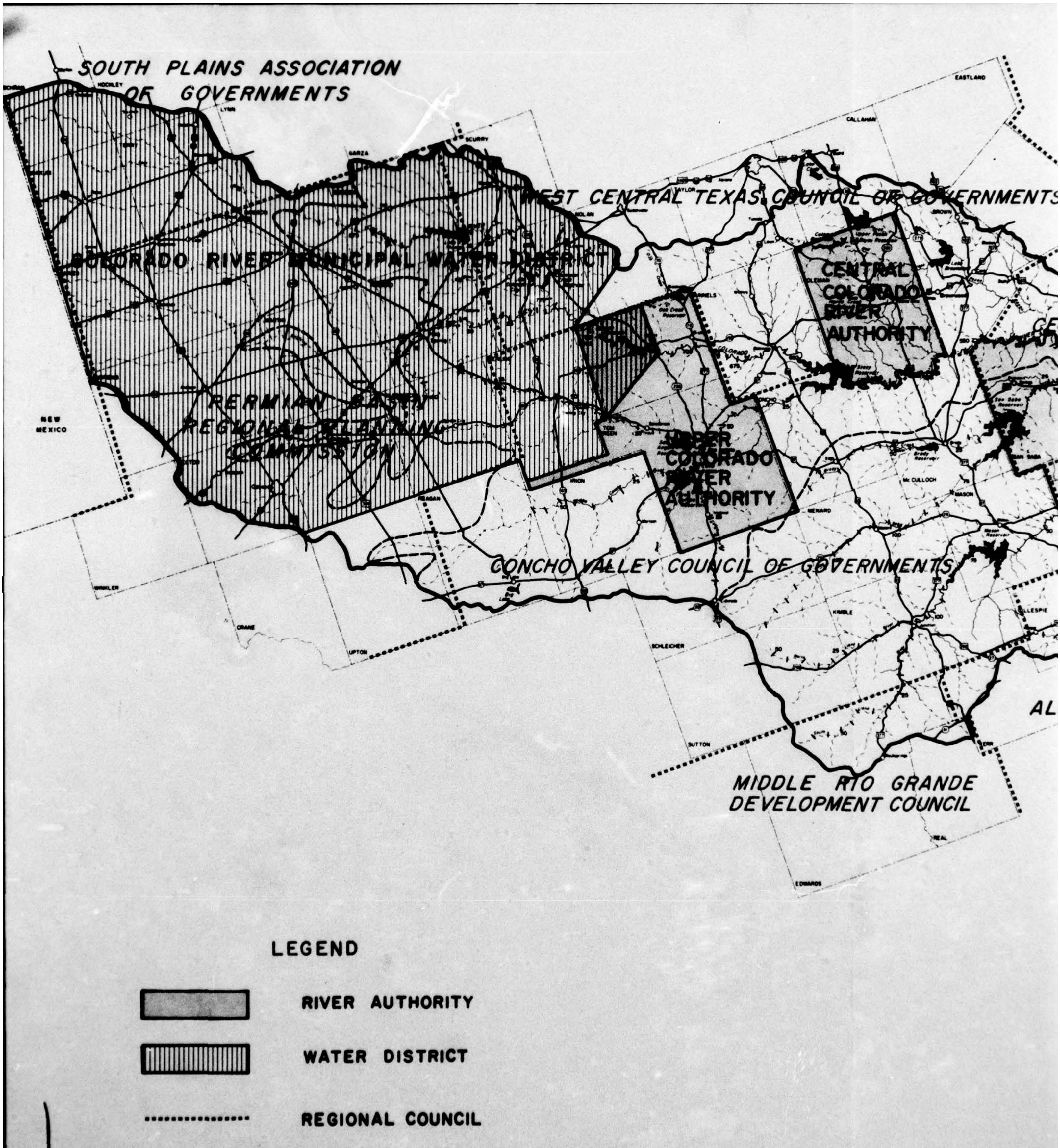
The jurisdictional boundaries of the subject COG's in relation to the Basin and a tabulation of the respective counties within each COG are presented in Plate II-3 and Table II-1, respectively.

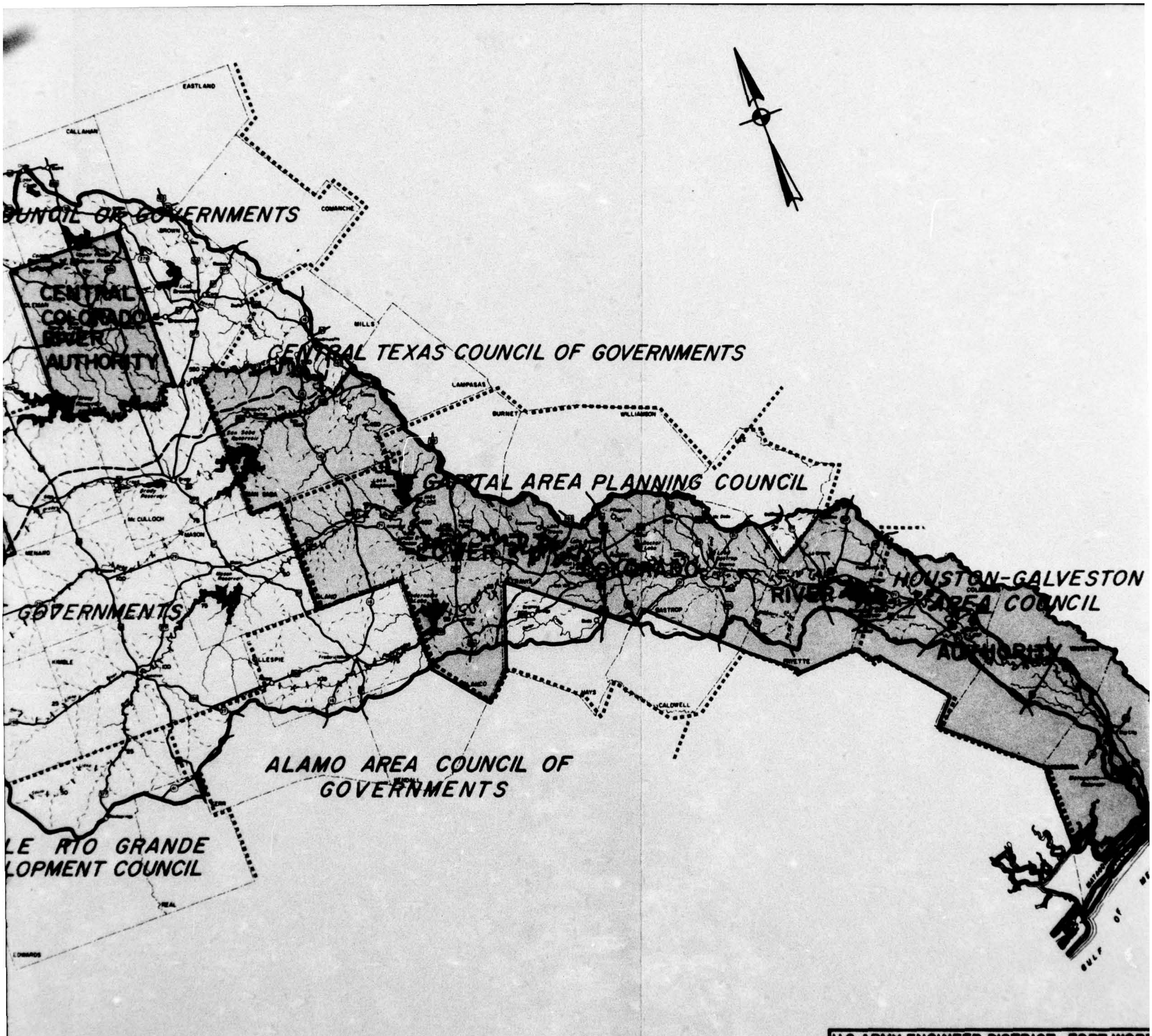
Whereas the Regional Council is primarily a functional planning coordinator, water districts are units of government which have been organized to fulfill a specific water resource function. Water districts can be created by special acts of the Legislature or under the general laws of authorization. River authorities, sanitation authorities, etc. are created by special acts of the Legislature. Under the general laws of authorization, districts can be created by a County Commissioners' Court (usually initiated by citizens' petition), the Texas Water Rights Commission, and by municipalities. There are fifty-seven such districts in the Colorado River Basin. These fifty-seven districts range from the multi-county river authority to the municipally-created district with only precinct authority.

Water districts are usually created due to the inability of the city or county to adequately provide certain types of specialized services. These Districts have operational autonomy so that they are not dependent on cities or counties for policy or control. The Districts have an established organization providing for election of officials and, in most cases, for levying of taxes and issuance of bonds.

Water districts vary greatly in purpose. However, all have been organized to provide some specific water-oriented service. By virtue of their legislation, river authorities are allowed to play four principal water quality related roles: First, financing quality-oriented projects; second, developing pollution abatement programs for their area; third, building and operating sewage treatment plants; and fourth, enforcing antipollution laws. While all districts do not have the same broad powers as the river authority, they do share a common power. That power is, by virtue of the Regional Waste Disposal Act, the authority to purchase, sell, or construct sewage collection and treatment facilities. Further, they are empowered to contract with any "public agency" to provide treatment of that agency's sewage in either the district's plant or in an agency plant operated by the district.

To date, there are no wastewater treatment plants in the Colorado River Basin owned or operated by a river authority. However, there are approximately six small county or municipal water districts which are providing wastewater collection and treatment facilities within the Basin. These smaller districts normally provide service to areas outside of incorporated city limits (i. e., Lakeway Municipal Utility District serves a recreational area and subdivision) or are formed to allow the development of a wastewater collection and treatment system within a incorporated town or city (i. e., Marble Falls Water Control and Improvement District No. 1 provides this service to the City of Marble Falls).


SOUTH PLAINS ASSOCIATION OF GOVERNMENTS
WEST CENTRAL TEXAS COUNCIL OF GOVERNMENTS
COLORADO RIVER MUNICIPAL WATER DISTRICT
CENTRAL COLORADO RIVER AUTHORITY
PERMIAN BASIN REGIONAL PLANNING COMMISSION
UPPER COLORADO RIVER AUTHORITY
NEW MEXICO
CONCHO VALLEY COUNCIL OF GOVERNMENTS
MIDDLE RIO GRANDE DEVELOPMENT COUNCIL
LEGEND
RIVER AUTHORITY
WATER DISTRICT
REGIONAL COUNCIL



U.S. ARMY ENGINEER DISTRICT, FORT WORT
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXA

JURISDICTIONAL BOUNDARIES
OF REGIONAL COUNCILS AND
MAJOR SPECIAL DISTRICTS

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ART

SCALE: 1" = 32 MILES | PLATE II-3

2

TABLE II - 1

REGIONAL COUNCILS IN THE COLORADO RIVER BASIN*

Alamo Area Council of Governments (AACOG) –
Gillespie, Kendall, and Kerr Counties

Capitol Area Planning Council (CAPCO) –
Bastrop, Blanco, Burnet, Caldwell, Fayette, Hays, Lee, Llano, and Travis Counties

Central Texas Council of Governments (CTCOG) –
Lampasas, Mills, and San Saba Counties

Concho Valley Council of Governments (CVCOG) –
Coke, Concho, Crockett, Irion, Kimble, Mason, McCulloch, Menard, Reagan, Schleicher, Sterling, Sutton, and Tom Green Counties

Houston-Galveston Area Council (H-GAC) –
Austin, Colorado, Matagorda, and Wharton Counties

Middle Rio Grande Development Council (MRGDC) –
Edwards and Real Counties

Permian Basin Regional Planning Commission (PBRPC) –
Andrews, Borden, Crane, Dawson, Ector, Gaines, Glasscock, Howard, Martin, Midland, Upton, and Winkler Counties

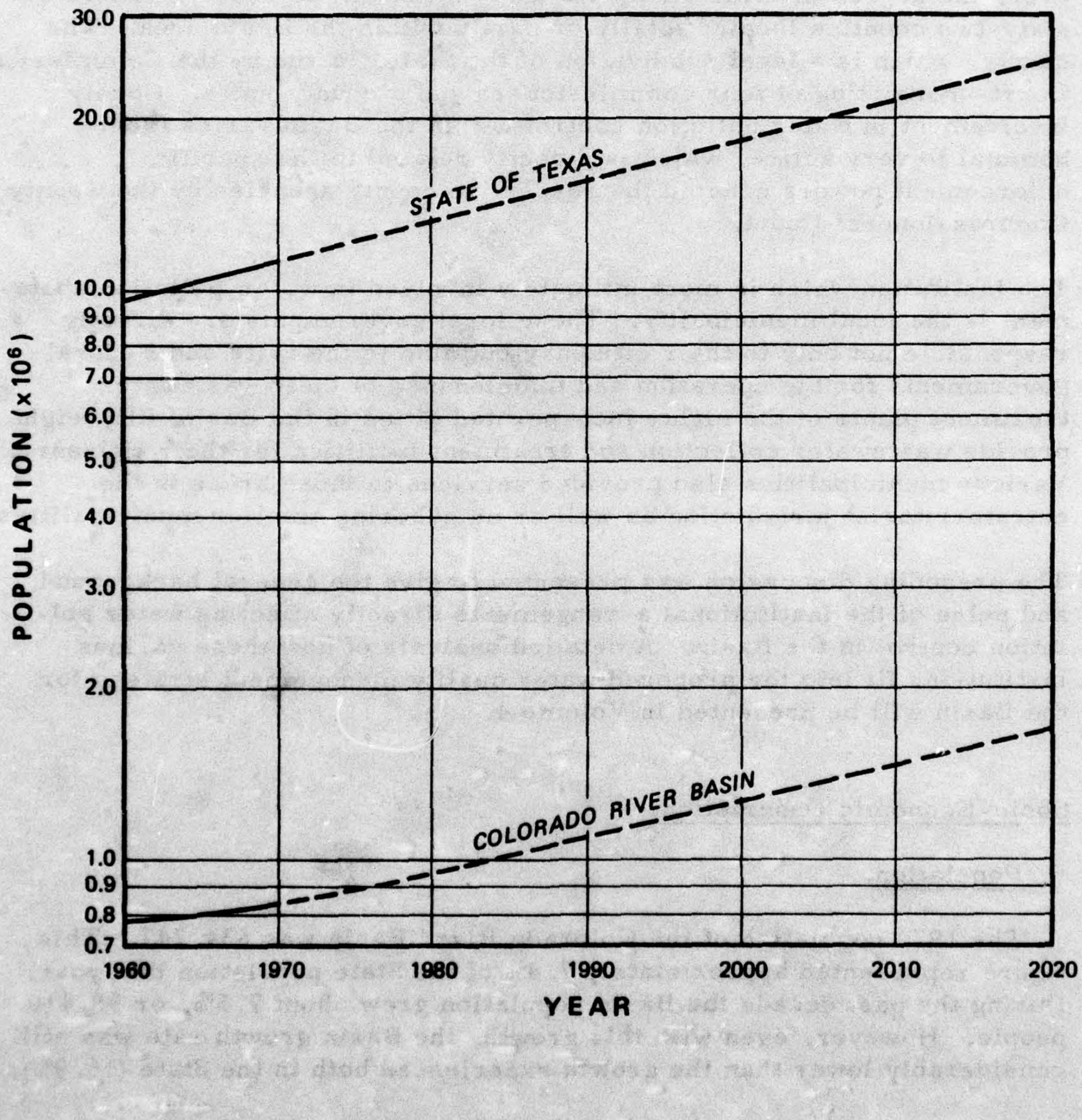
South Plains Association of Governments (SPAG) –
Cochran, Garza, Hockley, Lynn, Terry, and Yoakum Counties

West Central Texas Council of Governments (WCTCOG) –
Brown, Callahan, Coleman, Comanche, Eastland, Mitchell, Nolan, Runnels, Scurry, and Taylor Counties

Those counties shown do not constitute the entire council area, but rather are those counties within the council boundary which are partly or totally within the basin.

FIGURE II-12

PROJECTED POPULATION IN THE COLORADO RIVER BASIN



Four major State-created entities (see Plate II-3) have been assigned responsibilities related to water development within the Basin. They are the Lower Colorado River Authority, the Colorado Municipal Water District, the Central Colorado River Authority, and the Upper Colorado River Authority.

County government has a definite role in water quality management; however, the degree of involvement varies from county to county. There are sixty-two counties located totally or partly within the Basin area. The county, which is a legal subdivision of the State, is run by the Commissioners' Court--consisting of four commissioners and a county judge. County involvement in water pollution control within the Basin varies from nominal to very active, which is directly related to the specific enforcement powers granted the respective county agencies by the County Commissioners' Court.

The institution which is most intimately involved in water pollution abatement is the local municipality. These local governments are directly responsible not only to their citizenry but also to the State and Federal governments for the operation and maintenance of their wastewater treatment plants of the eighty incorporated cities in the Basin; fifty-eight provide wastewater collection and treatment facilities for their citizenry. Various municipalities also provided services to those areas in the extraterritorial jurisdiction as well as neighboring smaller municipalities.

The preceding discussion was presented to give the general background and pulse of the institutional arrangements directly affecting water pollution control in the Basin. A detailed analysis of how these various institutions fit into the proposed water quality management strategy for the Basin will be presented in Volume 4.

Socio-Economic Description.

Population.

The 1970 population of the Colorado River Basin was 834,747. This figure represented approximately 7.4% of the State population that year. During the past decade the Basin population grew about 7.5%, or 58,410 people. However, even with this growth, the Basin growth rate was still considerably lower than the growth experienced both in the State (16.9%),

and the Nation (13.3%), during the period 1960-1970. As seen in Table II-2, and graphically illustrated in Figure II-12, the Texas Water Development Board (TWDB) has projected the Basin population to increase to 1,087,550 by 1990 and 1,696,330 in the year 2020. Overall, the Basin is projected to experience a mild population growth. In fact, its population is projected to continue to grow at a slower rate than the State during the entire study period.

Table II-2

Historic and Projected Population of
The Colorado River Basin and the State of Texas

	Colorado River Basin		State of Texas	
Year	Population	% Growth	Population	% Growth
1960[1]	776,337		9,579,677	
		7.5		16.9
1970[1]	834,747		11,196,730	
		12.9		16.7
1980[2]	942,550		13,069,000	
		15.4		18.2
1990[2]	1,087,550		15,450,600	
		18.7		20.6
2020[2]	1,696,330		25,029,200	

[1] Population from 1960 and 1970 census respectively.

[2] Projections developed by TWDB.

Table II-3 illustrates the Basin population projections for the counties and selected cities in the Basin. The cities evaluated in the projections were those which now have or conceivably will require municipal wastewater treatment facilities during the study period. The projections were basically developed by the Texas Water Development Board. The forecasts were accomplished in three separate, yet related steps. Basically, the projections are an extension and extrapolation of the Population Projections for Texas Counties (1970-1990) as developed by the Population Research Center of the University of Texas under contract for the Governor's Office. A detailed procedure of the methodology used and appropriate sample calculations are included in Appendix A of the Basin Plan Appendixes (Volume 2).

TABLE II - 3

POPULATION PROJECTIONS
COLORADO RIVER BASIN

COUNTY / RC[1]	CITY	POPULATION 1970[2]	1980	1990	2020
Andrews		10,359	10,880	11,380	12,380
PBRPC	Andrews	8,625	8,780	8,970	9,070
	Other	1,734	2,100	2,410	3,310
Austin	Other	28	30	30	20
H-GAC					
Bastrop		16,859	17,990	19,290	22,100
CAPCO	Bastrop	3,112	3,470	3,930	5,210
	Elgin	3,832	4,360	4,940	6,650
	McDade	300	290	280	190
	Smithville	2,959	3,490	4,010	5,570
	Other	6,656	6,380	6,130	4,480
Blanco		1,840	1,840	1,900	1,840
CAPCO	Johnson City	767	830	900	1,030
	Other	1,073	1,010	1,000	810
Borden		860	870	870	780
PBRPC	Gail	178	220	260	340
	Other	682	650	610	440
Brown		25,843	26,470	27,260	27,760
WCTCOG	Bangs	1,214	1,220	1,260	1,300
	Blanket	346	350	360	370
	Brownwood	17,368	17,940	18,430	18,590
	Early	1,097	1,100	1,140	1,180
	May	300	300	310	320
	Zephyr	205	200	210	220
	Other	5,313	5,360	5,550	5,780
Burnet		8,991	9,450	10,000	11,100
CAPCO	Burnet	2,864	3,200	3,620	4,890
	Granite Shoals	342	330	330	320
	Marble Falls	2,209	2,260	2,300	2,240
	Other	3,576	3,660	3,750	3,650
Caldwell	Other	298	300	320	340
CAPCO					

[1] *Regional council*

[2] *1970 Census*

TABLE II - 3 (Cont'd.)

COUNTY	CITY	POPULATION 1970	1980	1990	2020
Callahan		2,848	2,820	2,860	2,780
WCTCOG	Clyde	1,635	1,620	1,640	1,595
	Cross Plains	1,192	1,180	1,200	1,160
	Other	21	20	20	25
Cochran		1,069	950	870	580
SPAG	Whiteface	394	350	320	210
	Other	675	600	550	370
*Coke		3,087	2,700	2,400	1,500
CVCOG	Bronte	925	800	710	430
	Robert Lee	1,119	990	890	590
	Other	1,043	910	800	480
*Coleman		10,288	8,600	7,100	3,900
WCTCOG	Coleman	5,608	4,560	3,690	1,900
	Santa Anna	1,310	1,130	950	560
	Other	3,370	2,910	2,460	1,440
Colorado		11,632	11,590	11,650	10,890
H-GAC	Columbus	3,342	3,540	3,670	3,780
	Eagle Lake [a]	1,793	1,900	2,000	2,050
	Garwood	961	910	890	750
	Weimar	2,104	1,990	1,940	1,640
	Other	3,432	3,250	3,150	2,670
Comanche WCTCOG	Other	46	40	40	40
*Concho		2,937	2,300	1,800	800
CVCOG	Eden	1,291	1,060	850	410
	Other	1,646	1,240	950	390
Crane PBRPC	Other	0	0	0	0
Crockett CVCOG	Other	21	20	20	10
Dawson		16,434	15,250	14,260	10,800
PBRPC	Ackerly	348	310	280	200
	Lamesa	11,559	10,910	10,270	7,940
	Other	4,527	4,030	3,710	2,660
Eastland WCTCOG	Other	94	80	70	40

**County totally within Basin*

[a] In-Basin (represents 50% of city population)

TABLE II - 3 (Cont'd.)

COUNTY		CITY	POPULATION 1970	1980	1990	2020
Ector			91,700	105,190	121,080	172,320
	PBRPC	Goldsmith	387	370	380	400
		Odessa	78,383	91,510	105,240	149,350
		Other	12,930	13,310	15,460	22,570
Edwards			1,472	1,500	1,570	1,410
	MRGDC	Rocksprings	1,221	1,300	1,400	1,300
		Other	251	200	170	110
Fayette			11,289	9,800	8,460	5,250
	CAPCO	Carmine	510	410	340	160
		Ellinger	200	160	130	60
		Fayetteville	400	330	270	130
		LaGrange	3,092	3,130	3,040	2,590
		Other	7,087	5,770	4,680	2,310
*Gaines			11,593	11,400	11,300	10,100
	PBRPC	Loop	315	300	290	240
		Seagraves	2,440	2,280	2,250	1,860
		Seminole	5,007	5,130	5,230	5,080
		Other	3,831	3,690	3,530	2,920
Garza		Other	0	0	0	0
	SPAC					
Gillespie			10,542	11,090	11,690	12,790
	AACOG	Fredericksburg	5,326	6,500	7,280	9,540
		Harper	383	340	320	240
		Other	4,833	4,250	4,090	3,010
*Glasscock			1,155	1,200	1,300	1,500
	PBRPC	Garden City	286	330	400	600
		Other	869	870	900	900
Hays			2,520	2,760	3,070	3,590
	CAPCO	Buda	498	550	610	720
		Dripping Springs	495	550	610	720
		Other	1,527	1,660	1,850	2,150
Hockley			1,640	1,430	1,360	1,100
	SPAG	Sundown	1,129	990	940	760
		Other	511	440	420	340
*Howard			37,796	40,400	43,400	50,100
	PBRPC	Big Spring	28,735	32,050	34,670	40,890
		Coahoma	1,158	1,090	1,140	1,200
		Forsan	237	220	230	240
		Sand Springs	903	840	870	920
		Other	6,763	6,200	6,490	6,850

TABLE II - 3 (Cont'd.)

COUNTY		CITY	POPULATION 1970	1980	1990	2020
*Irion			1,070	1,000	1,000	800
	CVCOG	Mertzon	513	490	490	400
		Other	557	510	510	400
Kendall		Other	67	70	70	80
	AACOG					
Kerr		Other	183	180	180	180
	AACOG					
*Kimble			3,904	3,700	3,600	3,000
	CVCOG	Junction	2,654	2,700	2,750	2,630
		Other	1,250	1,000	850	370
Lampasas			1,043	950	920	740
	CTCOG	Lometa	633	580	560	450
		Other	410	370	360	290
Lee			3,006	3,000	2,940	2,470
	CAPCO	Giddings[b]	2,088	2,250	2,330	2,180
		Other	918	750	610	290
* Llano			6,979	7,800	8,800	11,600
	CAPCO	Kingsland	1,262	1,400	1,580	2,050
		Llano	2,608	2,960	3,360	4,520
		Sunrise Beach	802	870	980	1,270
		Other	2,307	3,440	2,880	3,760
Lynn		Other	284	260	250	180
	SPAG					
*McCulloch			8,571	7,400	6,400	3,800
	CVCOG	Brady	5,557	5,130	4,600	3,040
		Melvin	290	230	180	80
		Other	2,724	2,040	1,620	680
*Martin			4,774	4,800	4,900	4,800
	PBRPC	Stanton	2,117	2,440	2,640	3,070
		Other	2,657	2,360	2,260	1,730
*Mason			3,356	2,700	2,200	1,200
	CVCOG	Mason	1,806	1,530	1,310	840
		Other	1,550	1,170	890	360

[b] *In-Basin (represents 75% of city population)*

TABLE II - 3 (Cont'd.)

COUNTY	CITY	POPULATION 1970	1980	1990	2020
Matagorda H-GAC	Other	1,657	1,710	1,890	2,390
*Menard		2,646	2,400	2,200	1,500
CVCOG	Menard	1,740	1,650	1,550	1,130
	Other	906	750	650	370
*Midland		65,433	68,700	72,400	79,100
PBRPC	Midland	59,463	62,340	65,310	70,130
	Other	5,970	6,360	7,090	8,970
Mills		3,100	2,640	2,310	1,400
CTCOG	Goldthwaite	1,693	1,590	1,490	1,110
	Other	1,407	1,050	820	290
*Mitchell		9,073	7,800	6,800	4,100
WCTCOG	Colorado City	5,227	4,630	4,150	2,720
	Loraine	700	570	480	250
	Westbrook	298	250	210	110
	Other	2,848	2,350	1,960	1,020
Nolan		726	610	570	430
WCTCOG	Blackwell	279	230	220	170
	Other	447	380	350	260
Reagan		3,240	2,790	2,490	1,500
CVCOG	Big Lake	2,489	2,210	2,000	1,250
	Other	741	580	490	250
Real MRCOG	Other	95	90	90	70
*Runnels		12,108	10,900	9,800	6,800
WCTCOG	Ballinger	4,203	4,050	3,850	3,110
	Miles	631	530	410	170
	Rowena	446	360	280	120
	Winters	2,907	2,900	2,800	2,390
	Other	3,921	3,060	2,460	1,010
*San Saba		5,540	4,400	3,500	1,700
CTCOG	Richland Springs	425	330	260	120
	San Saba	2,555	2,070	1,660	830
	Other	2,560	2,000	1,580	750
Schleicher		2,100	1,770	1,420	760
CVCOG	Eldorado	1,446	1,340	1,070	590
	Other	654	430	350	170

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TABLE II - 3 (Cont'd.)

COUNTY		CITY	POPULATION 1970	1980	1990	2020
Scurry			14,684	13,660	12,680	9,560
	WCTCOG	Hermleigh	711	610	540	360
		Ira	464	390	350	230
		Snyder	11,171	10,630	9,970	7,780
		Other	2,338	2,030	1,820	1,190
*Sterling			1,056	900	800	600
	CVCOG	Sterling City	780	690	620	490
		Other	276	210	180	110
Sutton		Other	375	290	260	150
	CVCOG					
Taylor			1,946	1,790	1,720	1,450
	WCTCOG	Lawn	344	320	310	260
		Tuscola	497	470	450	380
		Other	1,105	1,000	960	810
Terry			13,875	14,580	15,370	16,680
	SPAG	Brownfield	9,647	10,690	11,410	12,840
		Meadow	491	470	480	460
		Other	3,737	3,420	3,480	3,380
*Tom Green			71,047	81,500	93,900	133,800
	CVCOG	Christoval	216	220	250	290
		San Angelo	63,884	74,050	85,660	124,250
		Sanatorium	450	450	490	570
		Other	6,497	6,780	7,500	8,690
Travis			295,431	383,190	498,670	1,026,580
	CAPCO	Austin	251,808	326,880	429,920	912,110
		Del Valle	300	390	480	810
		Elroy	125	170	210	340
		Jonestown[c]	1,190	1,380	1,650	2,000
		Lago Vista[d]	88	4,500	11,230	33,000
		Lakeway[d]	730	5,000	9,300	21,890
		Manor	940	1,180	1,440	2,400
		Oak Hill	425	560	690	1,490
		Pflugerville	549	730	890	1,370
		Point Venture[d]	400	2,000	2,660	4,200
		Rolling Wood	780	1,010	1,240	2,060
		Sunset Valley	292	390	480	800
		West Lake Hills	1,488	1,910	2,340	3,890
		Other	36,316	37,090	36,140	40,220
Upton		Other	270	240	200	110
	PBRPC					

[c]*Projections taken from "The Highland Lakes System Comprehensive Wastewater Study 1970-1990."*
[d]*Projections taken from engineering report on respective area.*

TABLE II - 3 (Cont'd.)

COUNTY	CITY	POPULATION 1970	1980	1990	2020
Wharton		6,548	6,500	6,570	6,320
HGAC	El Campo[e]	1,713	1,820	1,800	1,660
	Wharton[f]	788	890	920	930
	Other	4,047	3,790	3,850	3,730
Winkler	Other	0	0	0	0
PBRPC					
*Yoakum		7,344	7,300	7,300	6,700
SPAG	Denver City	4,133	4,500	4,560	4,370
	Plains	1,087	950	930	790
	Other	2,124	1,850	1,810	1,540
BASIN TOTAL		834,747	942,550	1,087,550	1,696,330

[e] *In-Basin (represents 20% of city population)*

[f] *In-Basin (represents 10% of city population)*

As mentioned earlier, the Basin is projected to experience a mild, gradual population growth during the study period. During this period, the Basin county population of 39 counties is expected to decline. Of the 20 counties in which a growth is projected, 4 are metropolitan areas. Thirty-four of the counties in the Basin are urban; that is, the majority of the Basin county population is considered urban.[1] In fact, the majority of the 1970, as well as projected population, is considered urban--see Tables II-4 and II-5. (Tables 4 and 5 were developed from Table 3.) This relationship is graphically illustrated in Figure II-13.

Table II-4

Historic and Projected Urban and Rural Population Within the Colorado River Basin

Year	Basin Population	Urban Population	% of Basin	Rural Population	% of Basin
1970	834,747	611,306	73.2	223,441	26.8
1980	942,550	716,080	76.0	226,470	24.0
1990	1,087,550	854,260	78.5	233,290	21.5
2020	1,696,330	1,426,010	84.1	270,300	15.9

The fact that a higher percentage of the population is urban should not be construed to mean that the Basin is a highly urbanized area. On the contrary, the Basin has an average population density of only 20 people per square mile. Most of the population is located in one or two towns per county. This is particularly true in the upper portion of the Basin.

There are 31 urban areas within the entire Basin, and this number is projected to decrease to 28 in the year 2020. The 1970 urban component (73.2%) of the Basin population, while high, is less than the respective State figure of 79.7%. On the other hand, the Basin rural population component percent of 26.8% exceeds the State norm by 6.5%.

(1) An urban area is a community, incorporated or not incorporated, which has a population of 2,500 people or more.

TABLE II-5

POPULATION DISTRIBUTION AMONG REGIONAL COUNCILS IN COLORADO RIVER BASIN

REGIONAL COUNCIL	POPULATION			
	1970	1980	1990	2020
AACOG*	10,792	11,340	11,940	13,050
Urban	5,326	6,500	7,280	9,540
Rural	5,466	4,840	4,660	3,510
CAPCO	347,213	436,110	553,450	1,084,870
Urban	272,363	349,740	455,150	943,720
Rural	74,850	86,370	98,300	141,150
CTCOG	9,683	7,990	6,732	3,840
Urban	2,555	0	0	0
Rural	7,128	7,990	6,732	3,840
CVCOG	103,400	109,470	118,490	149,420
Urban	72,097	81,880	93,010	129,920
Rural	31,303	27,590	25,480	19,500
H-GAC	19,865	19,830	20,140	19,620
Urban	6,929	7,340	7,630	7,890
Rural	12,936	12,490	12,510	11,730
MRGDC	1,567	1,590	1,660	1,480
Rural	1,567	1,590	1,660	1,480
PBRPC	240,371	258,930	281,090	341,990
Urban	191,772	210,720	232,330	285,530
Rural	48,599	48,210	48,760	56,460
SPAG	24,202	24,520	25,150	25,240
Urban	13,780	15,190	15,970	17,210
Rural	10,422	9,330	9,180	8,030
WCTCOG	77,657	72,770	68,900	56,860
Urban	46,484	44,710	42,890	32,200
Rural	31,173	28,060	26,010	24,660

*Abbreviation for respective regional council.

TABLE II - 6

POPULATION PROJECTIONS FOR METROPOLITAN AREAS IN THE COLORADO RIVER BASIN

	1960		1970		1980		1990		2020
COLORADO RIVER BASIN	776,337		834,747		942,550		1,087,550		1,696,330
% Growth		7.5		12.9		15.4		18.7	
ABILENE SMSA	2,892		1,946		1,790		1,720		1,450
% Annual Growth		−3.3		−0.8		−0.4		−0.5	
% of Basin	0.4		0.2		0.2		0.2		0.1
AUSTIN SMSA	212,136		295,431		383,190		498,670		1,026,580
% Annual Growth		3.9		3.1		3.0		3.5	
% of Basin	27.3		35.4		40.6		45.8		60.5
MIDLAND SMSA	67,717		65,433		68,700		72,400		79,100
% Annual Growth		−0.3		0.5		0.5		0.3	
% of Basin	8.7		7.8		7.3		6.7		4.7
ODESSA SMSA	88,118		91,700		105,190		121,080		172,320
% Annual Growth		0.4		1.5		1.5		1.4	
% of Basin	11.4		11.0		11.2		11.1		10.2
SAN ANGELO	64,630		71,047		81,500		93,900		133,800
% Annual Growth		1.0		1.5		1.5		1.4	
% of Basin	8.3		8.5		8.6		8.6		7.9
TOTAL METRO AREAS	435,493		525,557		640,370		787,770		1,413,250
% of Basin	56.1		63.0		67.9		72.4		83.3

During the last decade, the most dynamic growth in the Basin occurred in the metropolitan areas, Standard Metropolitan Statistical Areas (SMSA's), as defined by the Office of Management and Budget. All or part of five SMSA's are located within the Basin: Midland (Midland County) Odessa (Ector County), San Angelo (Tom Green County), Austin (Travis and Hays County), and Abilene (Callahan, Jones and Taylor Counties). The population in these areas represented approximately 62.7% of the 1970 Basin total, which is somewhat less than the State norm of 73.5%. Table II-6 illustrates the growth of these areas during the last decade of record (1960-1970) and what portion of the Basin population is located in the areas.

With the exception of the portions of the Midland and Abilene SMSA's in the Basin, all of the metropolitan areas increased in population during the last decade. According to the forecasts, all of these areas, with the exception of the Taylor County population, will increase during the study period. It should be noted that all of the Taylor County population within the Basin is rural.

Undoubtedly, the most dynamic area of increase during the last decade has been the Austin-Travis County area. Travis County has grown 39% since 1960, and its 1970 population of 295,431 represents 35.4% of the total Basin population. Further, forecasts indicate that the Austin SMSA will represent 60.5% of the 2020 population in the Basin. The Odessa and San Angelo SMSA's are forecasted to experience appreciable growth during the study period, approximately 88% each. The 88% growth rate forecasted for the Odessa-San Angelo SMSA's is attributed generally to the notable increase in economic activity. As is evidenced by Table II-13, economic growth and development will increase by a substantial percentage during this period. The Midland SMSA population should remain fairly stable, as evidenced by its projected growth of 21% over the 50-year period.

While there is an increasing migration, especially from agricultural areas, to the urban areas, the trend seems to be slowing somewhat. The urban areas are becoming so saturated that the residents are migrating to the suburban and fringe areas. A good case in point is the Highland Lakes area. There, many urban dwellers of the Austin area have either built a weekend retreat or have settled permanently.

In view of the foregoing comments, it is readily apparent that the characteristics of the population of the State and Basin have undergone notable changes. Some of the more important characteristics of the State are delineated in Table II-7.

FIGURE II-13

URBAN AND RURAL POPULATION IN THE COLORADO RIVER BASIN

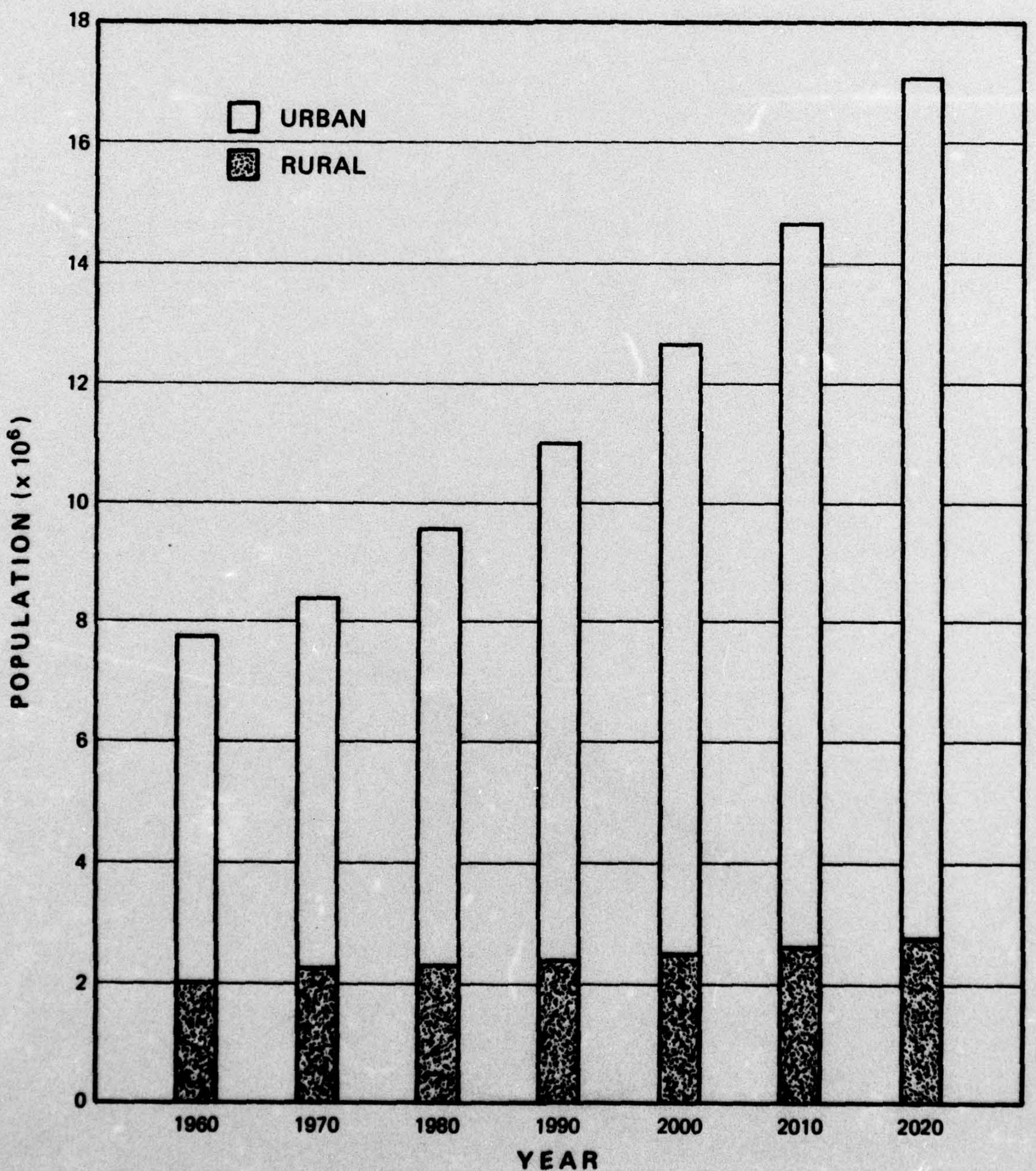


Table II-7

Population Characteristic of the State

Characteristic	1960[1]	1970[2]
Medium Age		
State	27.0	26.5
Urban	26.5	25.7
Rural[3]	28.9	28.7
Median Family Size		
State	3.36	3.12
Urban	3.34	3.17
Rural[3]	3.41	3.18
Median School Years Completed[4]		
State	10.4	11.6

The "OBERS Projections" were prepared by the Bureau of Economic Analysis (BEA), *formerly the Office of Business Economics* (OBE). Prior to January 1, 1972, preparation of these projections was a unified effort by the Office of Business Economics and the Economic Research Service, Department of Agriculture.

The OBERS publications were prepared in response to a need for basic economic information by public agencies engaged in comprehensive planning for the use, management, and development of the nation's water and related land resources. The publication represents a major output of a program of economic measurement, analysis and projections, and it is evident from their wide acceptance by both private and public concerns that the program has become an integral part of the comprehensive water resources planning program and the periodic national assessments of water and related land resources.

1 U.S. Bureau of the Census, 1960.

2 U.S. Bureau of the Census, 1970.

3 U.S. Bureau of the Census.

4 U.S. Bureau of the Census.

OBERS projections are used by numerous Federal agencies in the evaluation and development of various planning efforts. Therefore, the projections developed and used in this study were compared to those developed by OBERS. In the comparison, it was necessary to disaggregate OBERS data for economic areas and water resources planning areas. As shown in Table II-8 and II-9, comparisons were made for the State and for the Colorado River Basin. There were no major disparities found in the comparison inasmuch as the general trends of growth of the TWDB projection were found to be in line with OBERS. Therefore, it was felt that the projections used in the study were sufficiently close to OBERS so that the use of the TWDB projections in lieu of OBERS projections will have no significant effects on the recommendations of the report.

The State has been divided into planning regions for the purpose of facilitating functional planning throughout the State. The Basin population has been broken out to show the respective population distribution within those portions of the nine regional councils encompassed by the Basin. Understandably, the Capital Area Planning Council, which is virtually completely within the Basin, is the most populous council within the Basin. Table II-5 does show that in five out of the nine councils, the Basin population is predominately urban in nature.

Economic Development

Originally, the economy of the Basin was based solely on cattle ranching. However, severe overgrazing, coupled with the discovery of oil in the 1900's, led to the eventual decline of the cattle ranching industry in the Basin. Major oil and gas fields were discovered and developed in the area north and west of San Angelo, as well as the coastal areas of the Basin. Consequently, the economy of these areas became all but dependent on the petroleum industry. With the exception of Travis County in the central portion of the Basin, agriculture pursuits provided the main livelihood in large portions of the Basin. Since the location of the State Capital in Austin in 1850, the economy of the City of Austin and Travis County has grown considerably, due to the buildup of the necessary support activities required to operate a State government. Increased economic stability has been afforded the Austin area by the presence of the State University. The university complex has become a major factor in the economy of the Austin area.

TABLE II - 8

COMPARISON OF TWDB AND OBERS POPULATION PROJECTION FOR THE STATE OF TEXAS

	TWDB		OBERS	
Year	Population[1]	Average Annual Growth Rate	Population[2]	Average Ar. Growth Ra
1960	9,579,700		9,579,700	
		1.57		1.57
1970	11,196,700		11,196,700	
		1.56		1.42
1980	13,069,000		12,886,000	
		1.69		1.50
1990	15,450,600		14,960,000	
		1.62		1.40
2000	18,146,100		17,188,000	
		1.62		1.46
2020	25,029,200		22,990,000	

[1] *Texas Water Development Board projections.*

[2] *OBERS Preliminary Data.*

TABLE II - 9

COMPARISON OF TWDB AND OBERS POPULATION PROJECTIONS FOR THE COLORADO RIVER BASIN[1]

	TWDB		OBERS	
Year	Population[2]	Average Annual Growth Rate	Population[3]	Average Annual Growth Rate
1960	1,200,000[4]		1,200,000[4]	
		0.48		0.48
1970	1,259,000[4]		1,259,000[4]	
		0.97		0.73
1980	1,386,800		1,353,700	
		1.16		0.93
1990	1,557,100		1,485,600	
		1.21		0.86
2000	1,756,400		1,617,900	
		1.22		1.02
2020	2,240,000		1,983,800	

[1] ***Counties wholly or partially in the Colorado River Basin.***

[2] ***Texas Water Development Board Projections.***

[3] ***OBERS Preliminary Data.***

[4] ***U. S. Bureau of the Census.***

Agriculturally, the Basin is taking on somewhat a different appearance. Improved farming methods have resulted in large farming operations within the Basin, with the attendant migration of the small farmer to the city to earn a living. The total farmed acreage in the Basin increased slightly from 3,375,433 acres in 1960 to 3,702,879 acres in 1970. Thus, in 1970 approximately 14% of the Basin was devoted to active farming. The farming techniques and crops farmed vary throughout the Basin.

Table II-10

Crop Acreages in the Colorado River Basin - 1960 & 1970

Crop	1960	1970
Cotton	1,212,479	1,167,343
Fruit	179,923	230,083
Grain		
Corn	87,508	35,855
Rice	12,860	21,100
Oat	161,088	548,925
Sorghums	1,322,238	1,112,050
Wheat	180,288	215,686
Hay & Forage	148,267	226,639
Orchard Crops & Pecans	16,143	28,585
Peanuts	29,050	34,372
Vegetables	8,857	23,615
Other	16,732	58,626
Total Acreage	3,375,433	3,702,879

As seen in Table II-10, there are numerous crops grown in the Basin. Over the past decade, cotton and sorghum acreages have been highest. There has been an increased growth of grains within the Basin coincident with the growing number of animal feeder operations in the Basin. While the type of crop varies throughout the Basin, cotton and grains are popular in the upper Basin; grains, hay and forage in the central Basin; and

rice predominates in the coastal areas. It should also be pointed out that the total acreage noted above may not be truly representative of the actual physical acreage farmed in the Basin; that is, it is not uncommon for a farmer to harvest two crops on the same acreage during the year. This is particularly common in those instances where a crop is grown during a certain portion of the year, and some type of hay or forage is raised on the same acreage during the remainder of the year.

While the predominant amount of farming in the Basin is dry farming, irrigated farming is a key factor of the economy of the upper Basin. According to the TWDB, there has been and is projected to be a continual reduction in the amount of irrigated acreage in not only the upper Basin but throughout the Basin (Table II-11). In addition to the projected decline of irrigated acreage--from 894,252 acres in 1969 to 220,000 acres in 2020--the TWDB has estimated that there are another 2-1/2 million irrigable acres in the High Plains portion of the Basin, if supplemental water could be made available. Intense efforts have been made to obtain supplemental water to assist the dwindling ground water reservoirs, especially those of the Ogallala aquifer. However, to date the efforts have been futile. Some perspective as to what effect the reduction of irrigated acreage may have on the regional economy is obvious when one considers that in 1967 direct farm income from irrigated agriculture in the High Plains was estimated at an annual total of $363 million. Indirect income to the Texas High Plains during the same year incident to irrigated agriculture was estimated at $648 million.

Table II-11

Source of Water for Irrigated Areas
(In Acres)

	Surface Water	Ground Water	Total
1969	56,196	838,056	894,252
1975	58,836	705,823	764,659
1980	61,419	597,833	659,252
1990	66,700	381,800	448,500
2020	86,500	135,500	222,000

Livestock production in the Basin has changed notably in recent years. The low dollar-per-acre production has led to the decline of the low density, dry county, cattle production in the Basin. Today, the ranchers are concentrating on improving their pastures, and thus increasing their overall production while lowering the grazing acreage required. Further, in recent years there has been a growing trend to process cattle prior to slaughter. These process centers--feedlots--have increased steadily in number throughout the Basin. This operation has become exceedingly more attractive due to the low acreage requirements, short turnaround time, and quick profits. The upper and the central portions of the Basin have experienced the bulk of the growth in the feeder operations.

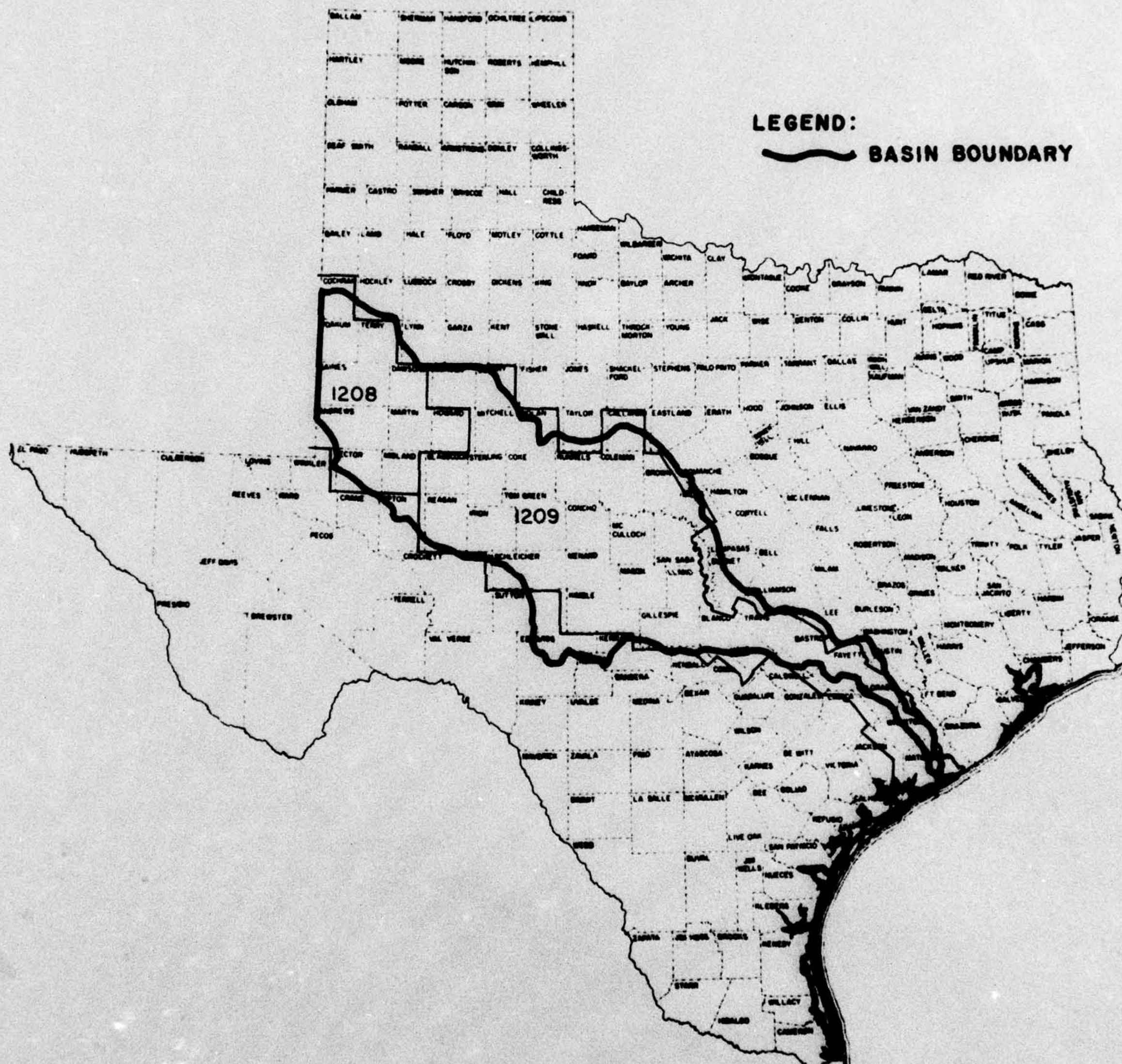
Sheep, goat, and poultry operations have become an integral part of the livestock base of the Basin, and commercial swine production has become prominent. Figure II-9 delineates the major agricultural components within the Basin.

While the agricultural sector is generally accepted as the key economic indicator in the Basin, the Basin does have some significant industrial development. The development has centered logically in urban areas, primarily the metropolitan areas. Undoubtedly, the single most dominant industry has been petroleum refining, petrochemical, and allied activities. There are extensive oil activities in the High Plains portion of the Basin as well as the coastal portion. The petroleum production in the Texas High Plains accounts for an estimated 36 percent of the State's total value of crude petroleum produced.

In 1972, based on various economic indicators, the Water Resources Council (WRC) developed projections on industrial growth in Water Resources Sub Area 1208, Colorado headwaters, and Water Resources Sub Area 1209, Lower Colorado (See Figure II-14 for delineation of area). Forecasts were made for the following six Standard Industrial Classifications (SIC):

SIC 20 Food and Kindred Products
SIC 22 Textile Mill Products
SIC 26 Paper and Allied Products
SIC 28 Chemical and Allied Products
SIC 29 Petroleum Refining
SIC 33 Primary Metals

FIGURE II-14
WATER RESOURCE SUB AREAS
COLORADO RIVER BASIN



SOURCE: U. S. Water Resource Council-OBERS, Volume 4, 1972.

These six were chosen because they are traditionally the heavy water-using industries. As indicated in Table II-12, there should be substantial industrial growth within the Basin during the remainder of the study period. Petroleum refining and the chemical allied products are expected to remain an important part of the economy of the Basin.

With any concentration of population comes the inherent commercial development. This sector of the economy, primarily product and service oriented, not only indicates the commercial growth in the general service community but also reflects the buying power of the area.

As in the case of the industrial sector, a representative sampling of the Wholesale-Retail Trade sector was taken. These were the two Water Resource Sub Areas 1208 and 1209 in the Basin. The results of these samplings for the Colorado River Basin have been interpolated to obtain the data contained in Table II-13, and graphically illustrated in Figure II-15.

Table II-13
Wholesale-Retail Trade[1]
(1967 $-thousands)

Water Resource Sub Area	1950	1969	1980	1990	2000	2020
1208	63,779	138,975	198,800	268,600	381,500	779,400
1209	142,335	228,910	384,700	584,500	914,400	2,110,100
TOTAL	206,114	367,885	583,500	853,100	1,295,900	2,889,500

As indicated by Table II-13, commercial development within the two Sub Areas increased 78% during the period 1950-1969. From 1969 through 1990, a growth of 132% is projected, and a 239% growth in commercial development is forecast during the period 1990-2020.

While somewhat localized in effect, recreational-related activities are becoming an integral part of the Basin economy, particularly in the Highland Lake Area. This area is a source of year-round recreation, featuring such items as sightseeing, hunting, fishing, boating, swimming, etc. The pleasant climate in the area complements the many recreation possibilities presented by the vast expanse of freshwater lakes. In

[1]U.S. Water Resources Council - OBERS, Vol 4, 1972

TABLE II - 12

PRODUCTION INDEXES FOR SELECTED INDUSTRIES[1]

WATER RESOURCE SUB AREA 1208
(Colorado Headwaters)

SIC	1969	1980	1990	2000	2010	2020
20	100[2]	127	161	212	281	382
22	–	–	–	–	–	–
26	–	–	–	–	–	–
28	100	200	343	594	996	1637
29	100	124	160	210	271	351
33	100	171	211	298	368	512

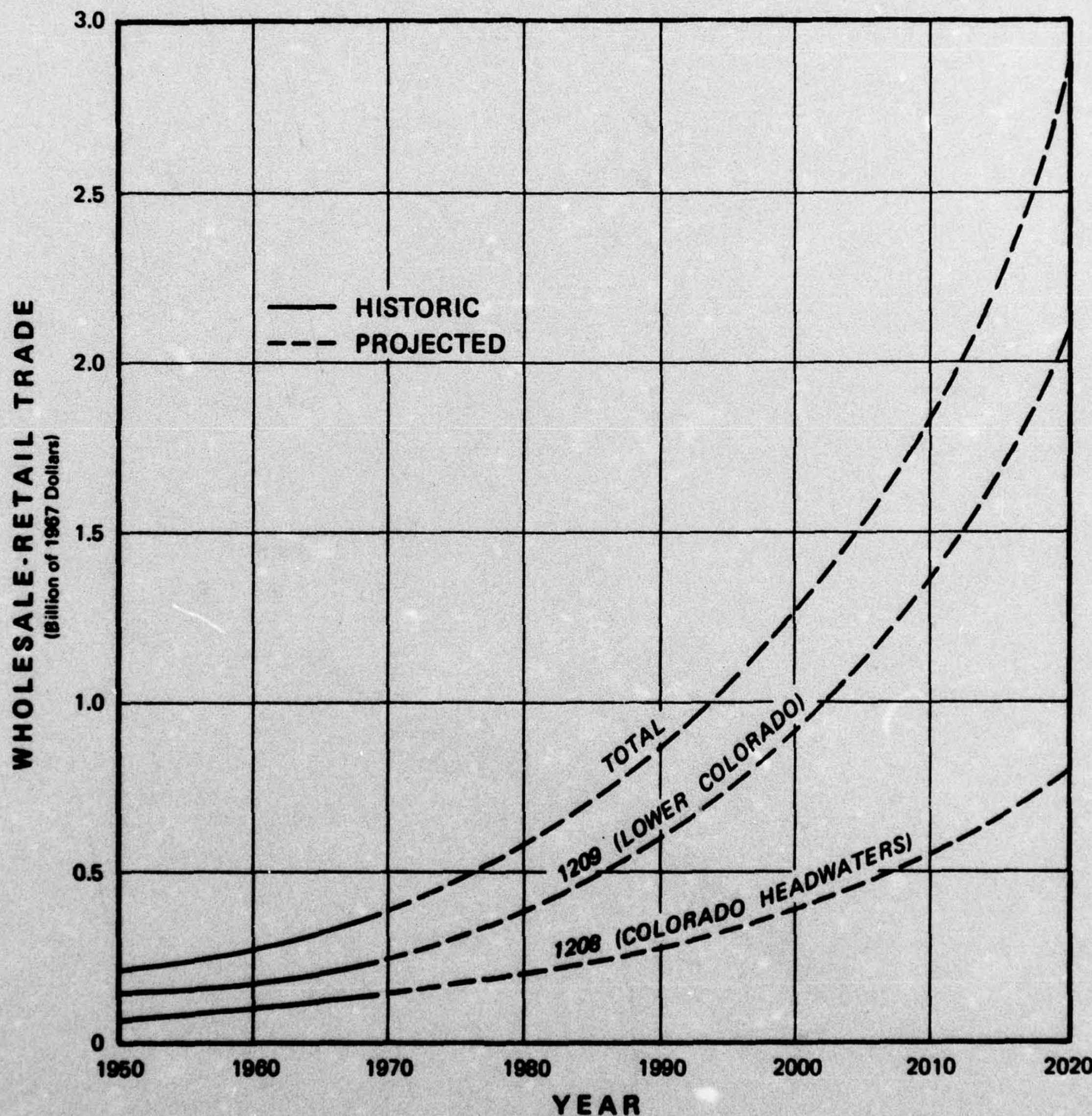
WATER RESOURCE SUB AREA 1209
(Lower Colorado)

SIC	1969	1980	1990	2000	2010	2020
20	100	141	186	253	336	447
22	100	211	298	422	605	848
26	100	(S)[3]	(S)[3]	(S)[3]	(S)[3]	(S)[3]
28	100	196	339	588	999	1661
29	100	283	404	583	830	1186
33	100	130	166	220	275	363

[1] *U. S. Water Resources Council – OBERS, 1972, Vol. 4*
[2] *Base year 1969 = 100.*
[3] *Too small to project.*

FIGURE II-15

VOLUME OF WHOLESALE-RETAIL TRADE IN WATER RESOURCE SUB AREAS ENCOMPASSING THE COLORADO RIVER BASIN



addition to the recreation services, the area has also become a second home for many Texans and is also gaining popularity as a permanent-resident site. There is some associated development around Lake Brownwood and a few of the other freshwater lakes in the Basin; however, none have had a similar impact on the economy of the immediate area as have the Highland Lakes.

Employment

The people of the Basin are employed in many varied industrial sectors. The total employment for those counties wholly or partially within the Basin amounted to 477,231 people in 1970. Table II-14 illustrates the numerous sectors employing people in the Basin, the employment per sector, and what relation the sector's employment has to the total employment. As expected, the agriculture sector has a slight edge in total employment.

Unemployment in the State decreased from 4.5% in 1960 to 3.6% in 1970. According to the 1970 Census, unemployment within those counties in the Basin ranged from 0.3% in Menard County to 6.3% in Mitchell County. The average labor force in the State during 1970 was approximately 4,693,600 people, which represented a notable increase over the 1960 value of 3,600,900 people.

Employment in the Basin is expected to respond generally to economic development within the Basin. Some idea as to employment potential in the Basin is evidenced in the Total Employment Data (Table II-15) developed by the Water Resources Council for those two Sub Areas in the Colorado River Basin. According to this data, there has been a 41% increase in total employment during the period 1950-1969. Fairly moderate increases of 9% and 10% are forecast from the periods 1969-1980 and 1980-1990, respectively. A 44% increase in employment is projected between 1990 and 2020. These trends are graphically illustrated in Figure II-16.

TABLE II - 14

1970 EMPLOYMENT FOR COUNTIES IN THE COLORADO RIVER BASIN BY INDUSTRIAL SECTOR[1]

INDUSTRIAL SECTOR	NUMBER EMPLOYED	% OF TOTAL EMPLOYMENT
Agriculture, Forestry and Fisheries	42,534	8.9
Banking	6,861	1.4
Business and Repair Service	14,996	3.2
Chemicals and Allied Products	3,200	0.7
Communications	6,438	1.3
Construction	37,628	7.9
Eating and Drinking Places	16,298	3.4
Electrical Machinery Equipment and Supplies	2,665	0.6
Entertainment and Recreation Services	3,317	0.7
Food and Kindred Products	5,163	1.2
Food, Bakery and Dairy Stores	12,167	2.5
Furniture, Lumber and Wood Products	2,567	0.5
General Merchandise Retailing	11,019	2.3
Government Schools	35,500	7.5
Health Services Except Hospitals	12,309	2.6
Hospitals	14,602	3.2
Insurance, Real Estate, Other Finance	13,063	2.7
Legal Engineering and Other Professional	12,508	2.6
Machinery Except Electrical	4,452	0.9
Metal Industries	2,969	0.6
Mining	27,194	5.7
Motor Vehicles	16,328	3.4
Other Durable Goods	6,571	1.4
Other Education	2,900	0.6
Other Non-Durables	5,166	1.1
Other Personal Services	18,643	3.9
Other Retail Trade	30,304	6.3
Other Transportation	3,048	0.6
Printing, Publishing and Allied Industries	4,758	1.0
Private Households	12,535	2.6
Private Schools	11,026	2.3
Public Administration	30,233	6.3
Railroads and Railway Express	2,170	0.5
Textiles	4,282	0.9
Transportation Equipments	2,877	0.6
Trucking Service and Warehousing	5,897	1.2
Utilities	9,153	1.9
Welfare, Religion and Other Nonprofit	7,945	1.7
Wholesale Trade	15,945	3.3
Total	477,231	

[1] *1970 Census*

Table II-15
Total Employment [1]

Water Resource Sub Area	1950	1969	1980	1990	2020
1208	68,716	129,002	131,300	136,000	173,700
1209	206,018	258,999	291,400	327,900	492,000
TOTAL	274,734	388,001	422,700	463,900	665,700

Income

Median family income in the State in 1970 was $8,490. A brief review of the median family income figures for those counties in the Basin revealed that only five of the sixty-two counties were higher than the State average. The county values ranged from $10,457 in Midland County to $4,531 in San Saba County. Although only five counties exceeded the state average of $8,490, none of the county median values fare below the officially recognized poverty level of $4,200.

Total earning figures for the Basin were developed by the Water Resources Council (Table II-16) for the period 1950 through 2020.

Table II-16
Total Earnings [1]
(1967 $ - thousands)

Water Resource Sub Area

Year	1208	1209	Total
1950	350,457	740,663	1,091,120
1969	858,262	1,403,751	2,262,013
1980	1,207,200	2,227,300	3,434,500
1990	1,610,300	3,343,100	4,953,400
2000	2,252,500	5,170,600	7,423,100
2020	4,508,900	11,771,400	16,280,300

[1] U.S. Water Resources Council - OBERS, Vol. 4, 1972

Historically, according to the data, there has been an overall increase in Basin earnings of 107%. Total earnings are forecasted to continue to climb during the remainder of the study period. Figure II-17 illustrates clearly that growth was more pronounced in Sub Area 1209 than 1208. The trend is expected to continue throughout the study period.

FIGURE II-16

TOTAL EMPLOYMENT IN WATER RESOURCE SUB AREAS ENCOMPASSING THE COLORADO RIVER BASIN

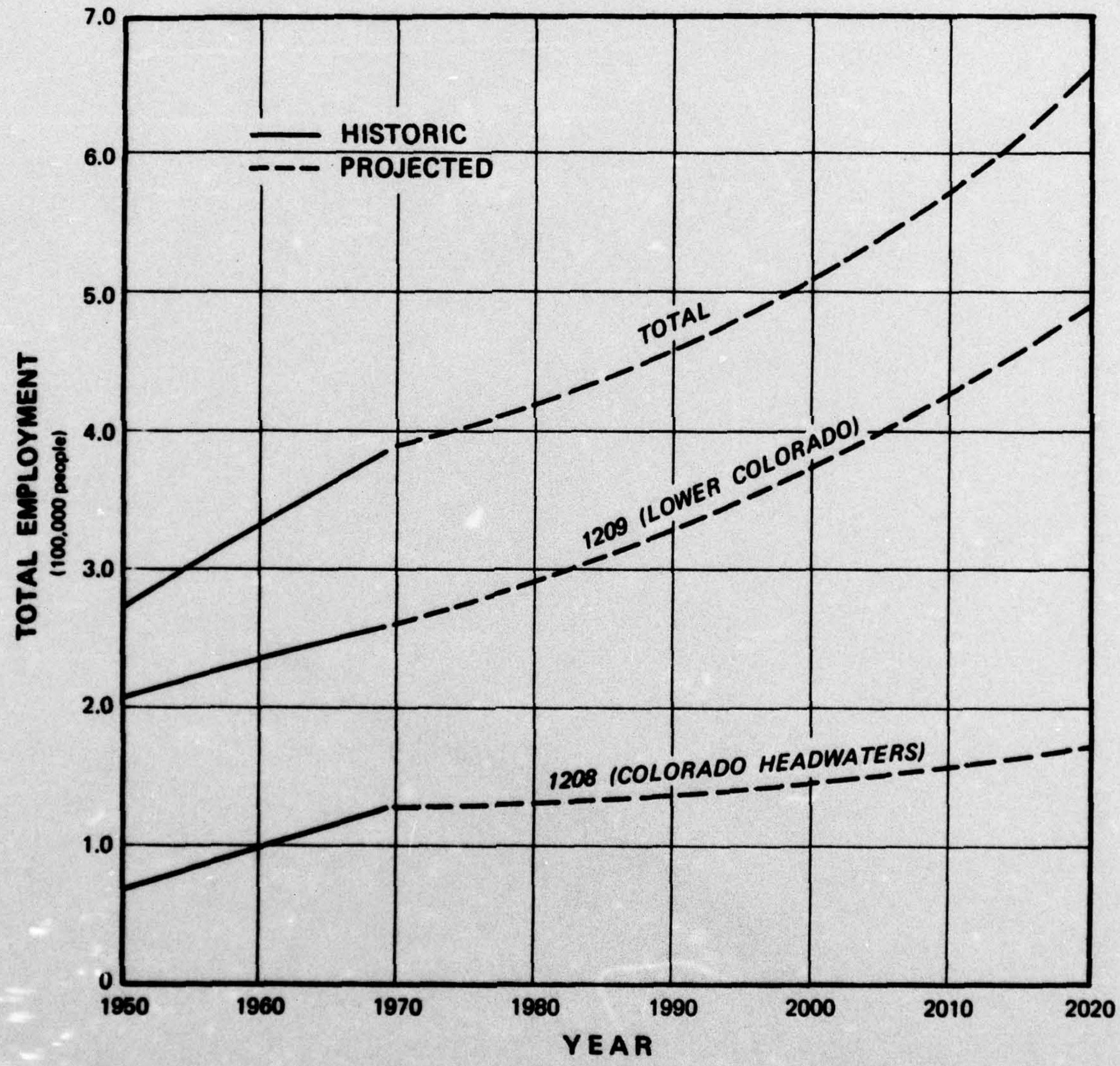
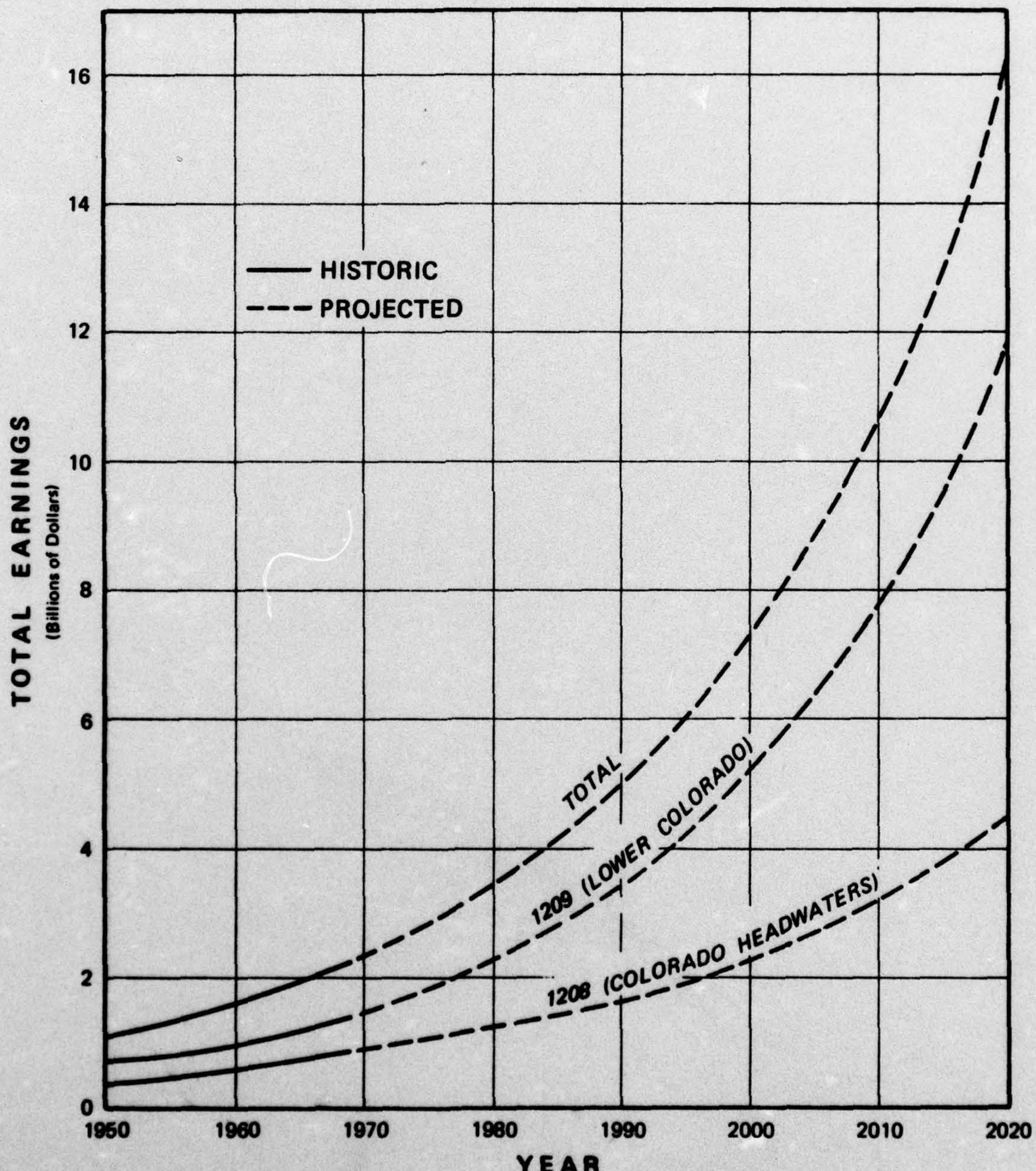


FIGURE II-17

TOTAL EARNINGS WITHIN THE WATER RESOURCE SUB AREAS ENCOMPASSING THE COLORADO RIVER BASIN



III. WATER RESOURCES

General.

The people in the Colorado River Basin are keenly aware of the importance of water resources, its protection, and the proper and timely development of this resource. This is particularly true in the semi-arid portion of the Basin, those counties west of and immediately east of the escarpment referred to as the Cap Rock. The people in this area are to some extent dependent on ground water reservoirs, particularly the Ogallala Aquifer, for water supply. The plight of the people in this area is becoming more acute, as evidenced by the fact that the Ogallala is being severely overpumped such that the recharge is insignificant in comparison with pumpage. The people in the High Plains have responded by launching a dedicated effort to resolve the water shortages and avoid the inevitable deterioration of their economy coincident with the continued depletion of the ground water reservoirs in the Ogallala.

While the problem is more severe in the upper Basin, scattered instances of water shortages are experienced from year to year throughout other portions of the Basin. This was readily apparent during the severe drought of the 1950's which crippled the economy of several parts of the State. Periodic semi-droughts, such as that during the period 1962-1968, affect certain portions of the Basin and have a telling effect on the area concerned. These droughts have contributed to the migration of people to the cities, and this further complicated the many ramifications that urban concentration and incident urban sprawl pose on the water resources of the Basin.

The water resource situation in the Basin is thus understandably complex. It is the purpose of the following discussion to examine in detail this situation and review the key components relating to existing water resources, projected water requirements, and proposed plans of development required to meet the projected needs. As seen in the following narrative, this discussion is couched in terms of zone requirements. There are four zones, and they are delineated in Figure III-1. These zones coincide with those zones used by the Texas Water Development Board (TWDB) in the development of the proposed plan of development for the Colorado River Basin, as outlined in the Texas Water Plan of 1968. It should be noted that the proposed plan of development, discussed later in this section, is the same as that proposed in the Texas Water Plan.

An analysis of streamflow conditions throughout the Colorado River and its principal tributaries is also presented in the following discussion. It addresses primarily the origin of streamflow, flow deviation, factors affecting streamflow, and low flow conditions. The designated low flow condition for this study was the seven-day, ten-year low flow.

Surface Water.

Surface water is a valuable commodity in a major portion of the Basin. In the High Plains region of the Basin, the natural salt lakes and playa lakes and a few man-made reservoirs comprise virtually all of the evident surface water. In the central portion of the Basin, climatological and hydrologic conditions result in the increased presence of surface water. Springs in the Edwards Plateau provide the base flow of streams in the central portion.

Although an abundance of surface water exists in the coastal areas, ground water is still utilized to satisfy many requirements. In the following paragraphs, surface water, its occurrence and development are reviewed in detail.

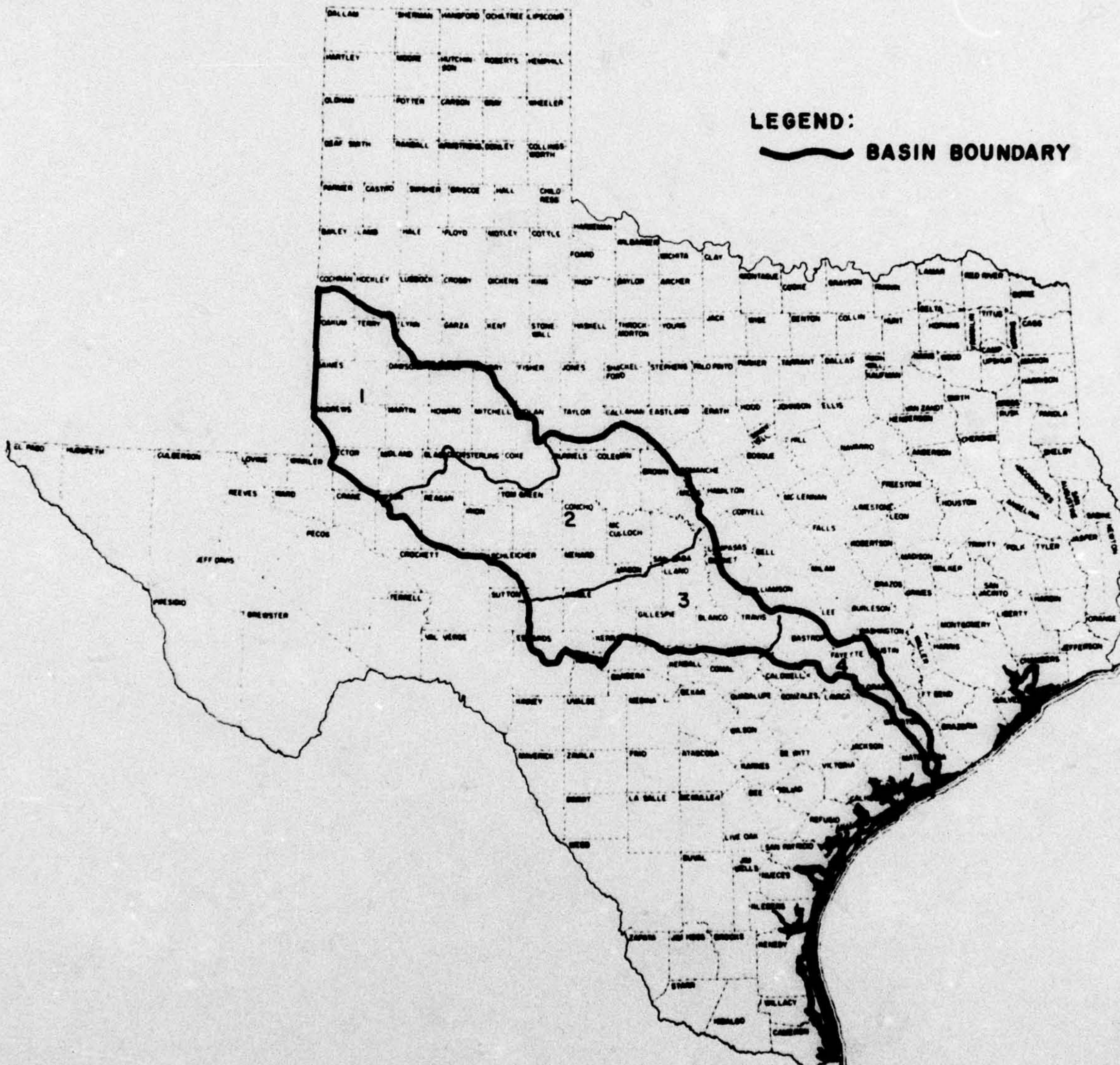
Streamflow.

Streamflow in the Colorado River Basin varies considerably in frequency and in duration, not only throughout the Basin but also within the main stem and tributaries as well. Most of the streamflow originates as runoff from the 29,863 square miles of contributing area within the Basin. The remainder of the available streamflow -- base flow -- is spring flow.

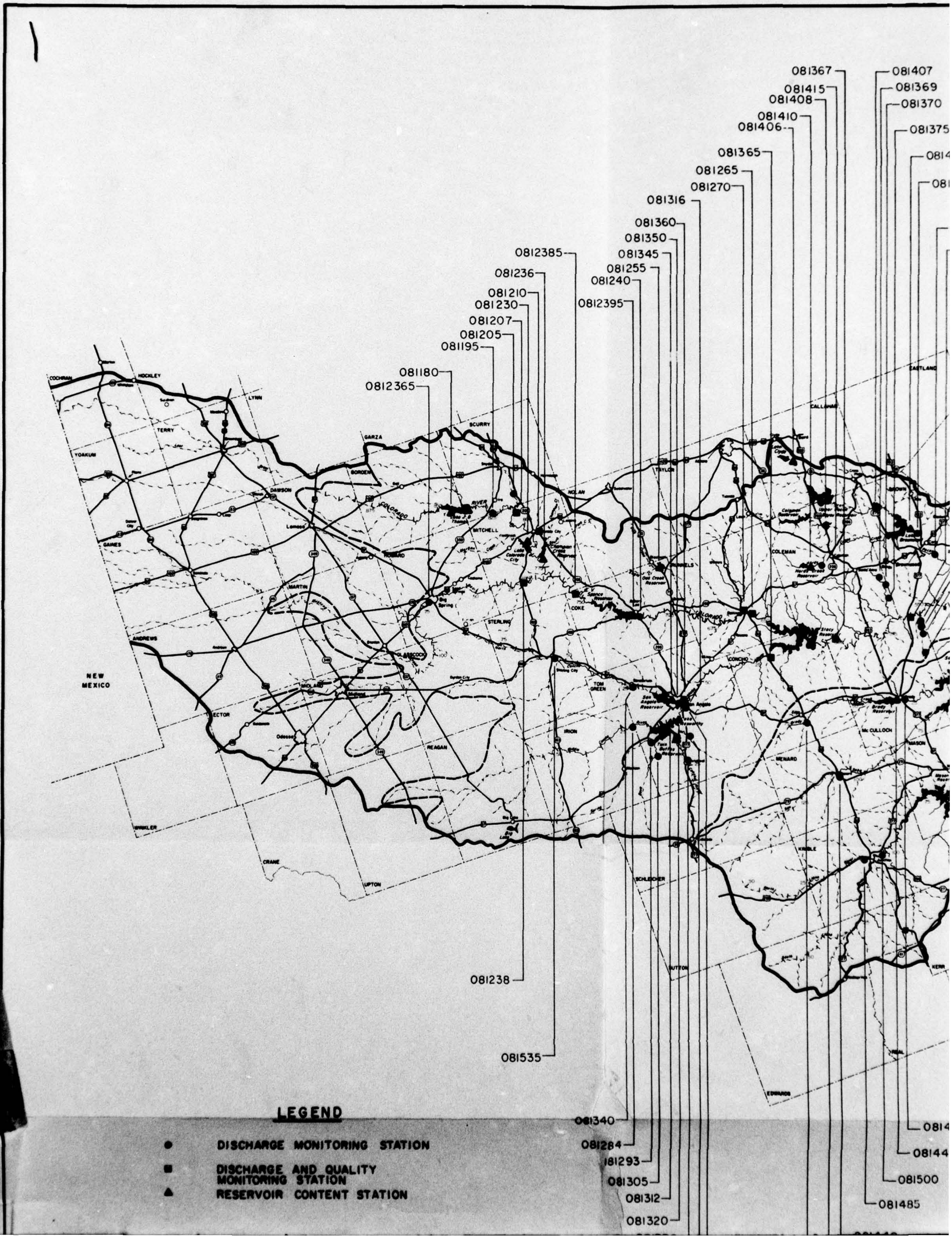
Flow conditions throughout the Basin are monitored by a comprehensive network of gaging stations as shown in Plate III-1, operated by the U.S. Geological Survey (USGS). Specific details on gaging station's name, location, etc. is included in the Appendixes. This network also includes numerous reservoir-content monitoring stations. Quality data are obtained at several of these stations, and the results of these analyses will be reviewed in the Water Quality discussion.

FIGURE III-1

TEXAS WATER DEVELOPMENT BOARD ZONE DIVISIONS COLORADO RIVER BASIN



SOURCE: "A Summary of the Preliminary Plan for Proposed Water Resources Development in the Colorado River Basin," Texas Water Development Board, July 1966.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081207
081205
081195
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TERRY
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GARZA
SCURRY
BORDEN
DAWSON
GAINES
NOLAN
TAYLOR
CALLAHAN
EASTLAND
BROWN
MITCHELL
HOWARD
MARTIN
COLORADO
RIVER
ANDREWS
NEW MEXICO
GLASSCOCK
STERLING
COKE
RUNNELS
COLEMAN
CONCHO
TOM GREEN
MIDLAND
ECTOR
REAGAN
IRION
MENARD
McCULLOCH
MASON
KIMBLE
SCHLEICHER
SUTTON
CRANE
UPTON
WINKLER
KERR
REAL
EDWARDS
081238
081535
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081305
081312
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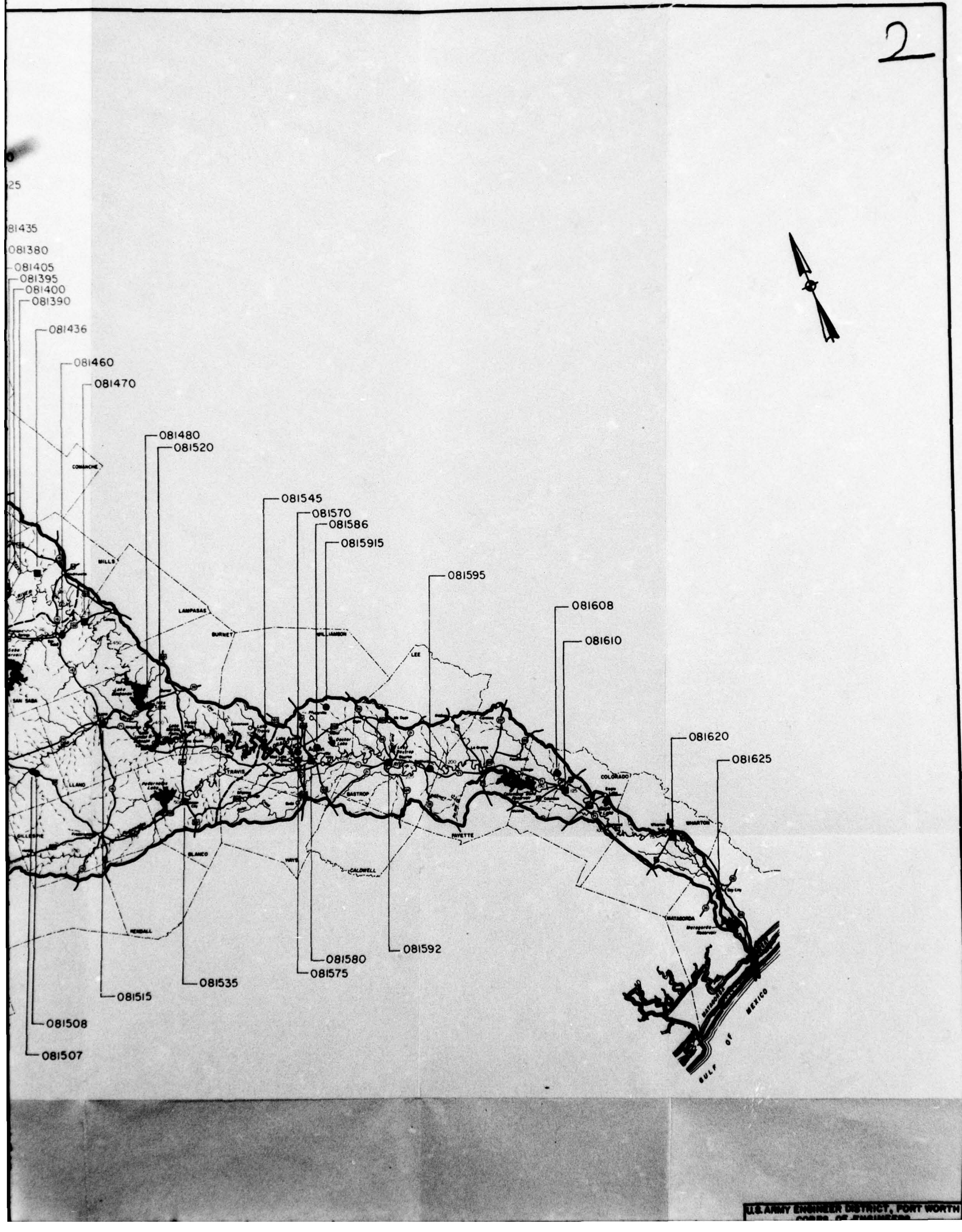
LEGEND
DISCHARGE MONITORING STATION
DISCHARGE AND QUALITY MONITORING STATION
RESERVOIR CONTENT STATION



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081586
0815915
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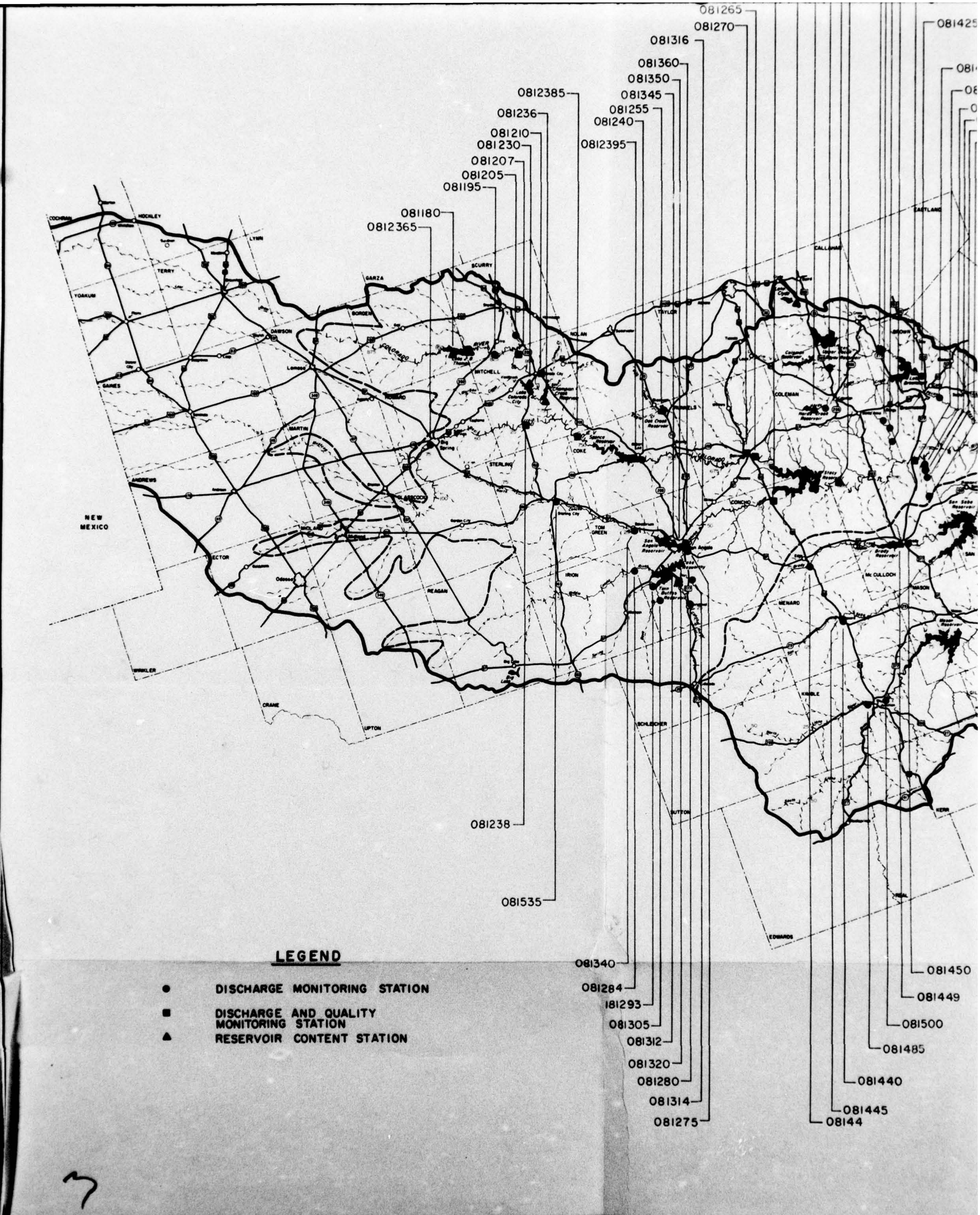
081608
081610
081620
081625
081592
081580
081575
081535
081515
081508
081507
COMANCHE
MILLS
LAMPASAS
BURNET
WILLIAMSON
LEE
SAN SABA
LLANO
TRAVIS
BASTROP
FAYETTE
COLORADO
WHARTON
MATAGORDA
GILLESPIE
BLANCO
HAYS
CALDWELL
KENDALL
GULF OF MEXICO
U.S. ARMY ENGINEER DISTRICT, FORT WORTH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081500
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081450
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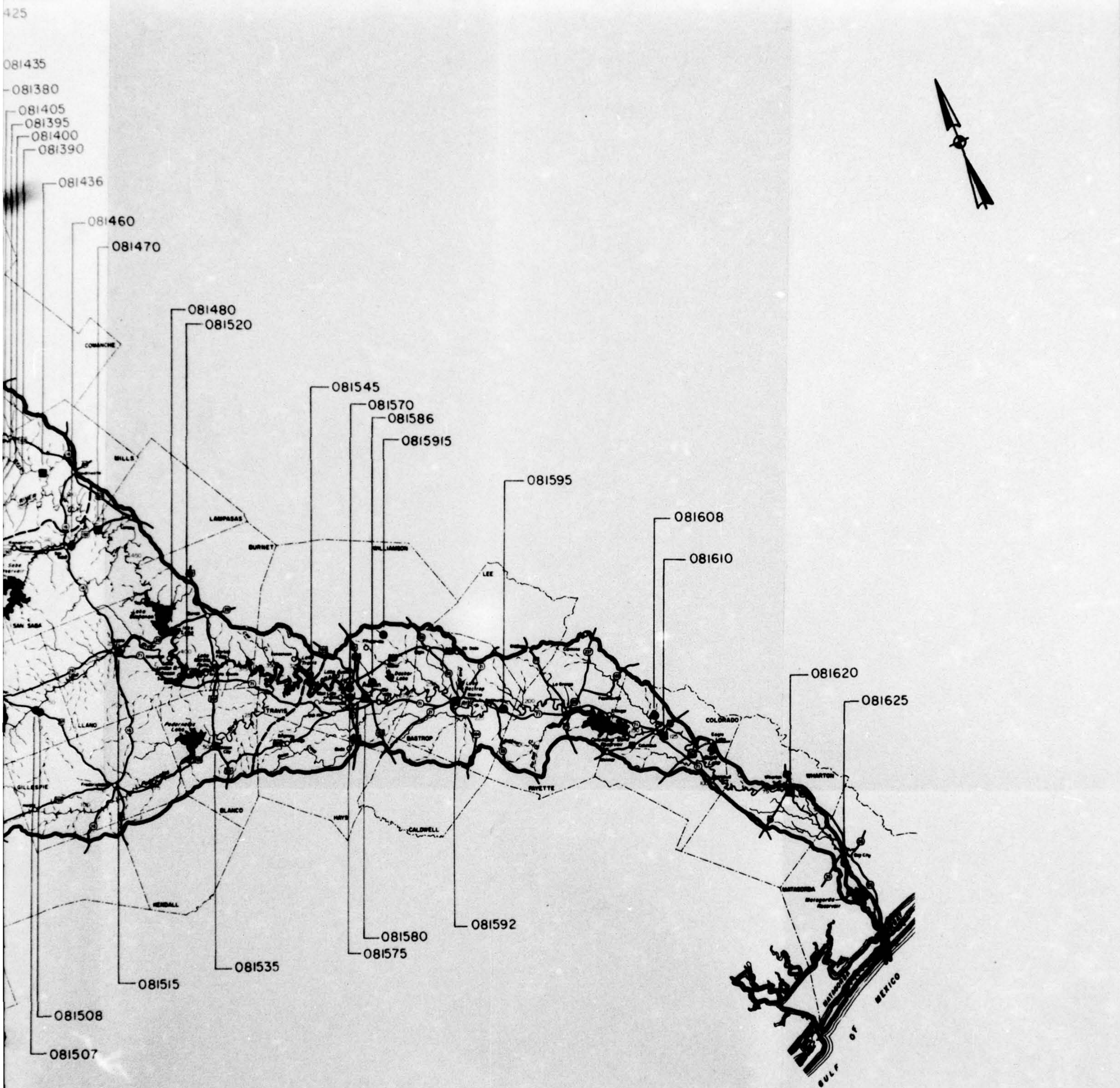
LEGEND
DISCHARGE MONITORING STATION
DISCHARGE AND QUALITY MONITORING STATION
RESERVOIR CONTENT STATION



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

USGS MONITORING
STATION NETWORK

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 26 MI. | PLATE III-1

Twenty-one of the streamflow gaging stations (Plate III-2) were selected as key stations for use in the streamflow analysis. The data shown for the respective stations were provided by the USGS and/or the TWDB. The flow-duration data presented are representative of current conditions at that station. The base flow condition used in the following analysis is the seven-day, ten-year low flow. The relation of the selected low flow condition, at the key stations, to other commonly used low flows is illustrated in Table III-1.

Colorado River.

Streamflow in the Colorado River varies notably throughout its 900-mile traverse across the State. There is very little, if any, streamflow in the upper 57-mile reach of the River. In fact, the predominant surface water feature in this reach is Lake J. B. Thomas, which is sustained primarily from periodic storm runoff. By virtue of a diversion structure, the reservoir also receives runoff from Bull Creek. There are no streamflow stations in this initial reach.

The first key stream gaging station (081210)[1] is located at Colorado City, approximately 45 miles downstream from Lake J. B. Thomas. The reservoir has had very little effect on the flow-duration characteristics of the stream at this station. The average discharge monitored at the station over the 25 years of record is 51.4 cfs. However, closer scrutiny of the data reveals that the flow in the stream is less than 1.5 cfs 50 percent of the time (during an average year), and 25.1 percent of the time (92 days a year) there is no flow. Low flow conditions at this station are directly affected by the diversion of saline water from the river three miles upstream during periods of low flow. The Colorado River Municipal Water District diverts these low flows with chloride concentrations in excess of 3000 mg/l into an off-channel reservoir to protect E. V. Spence Reservoir from chloride contamination. The District diverted an average of 107,869,000 gallons a month (about 3,973 acre-feet/year) during 1972.

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[1] U.S. Geological Survey Station Number

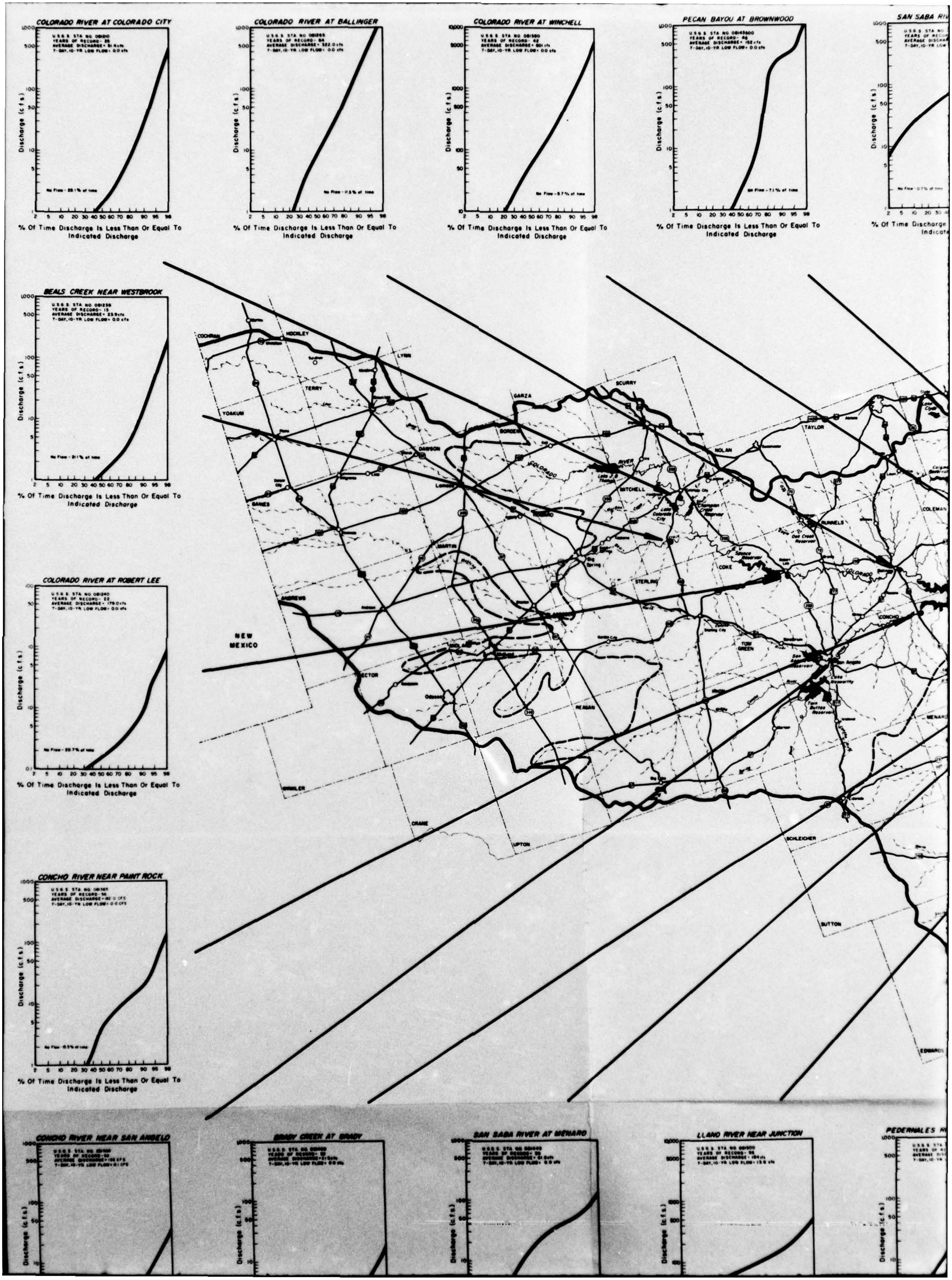
TABLE III-1

7-DAY LOW-FLOWS AT SELECTED STREAM GAGING STATIONS IN THE COLORADO RIVER BASIN

(in cfs)

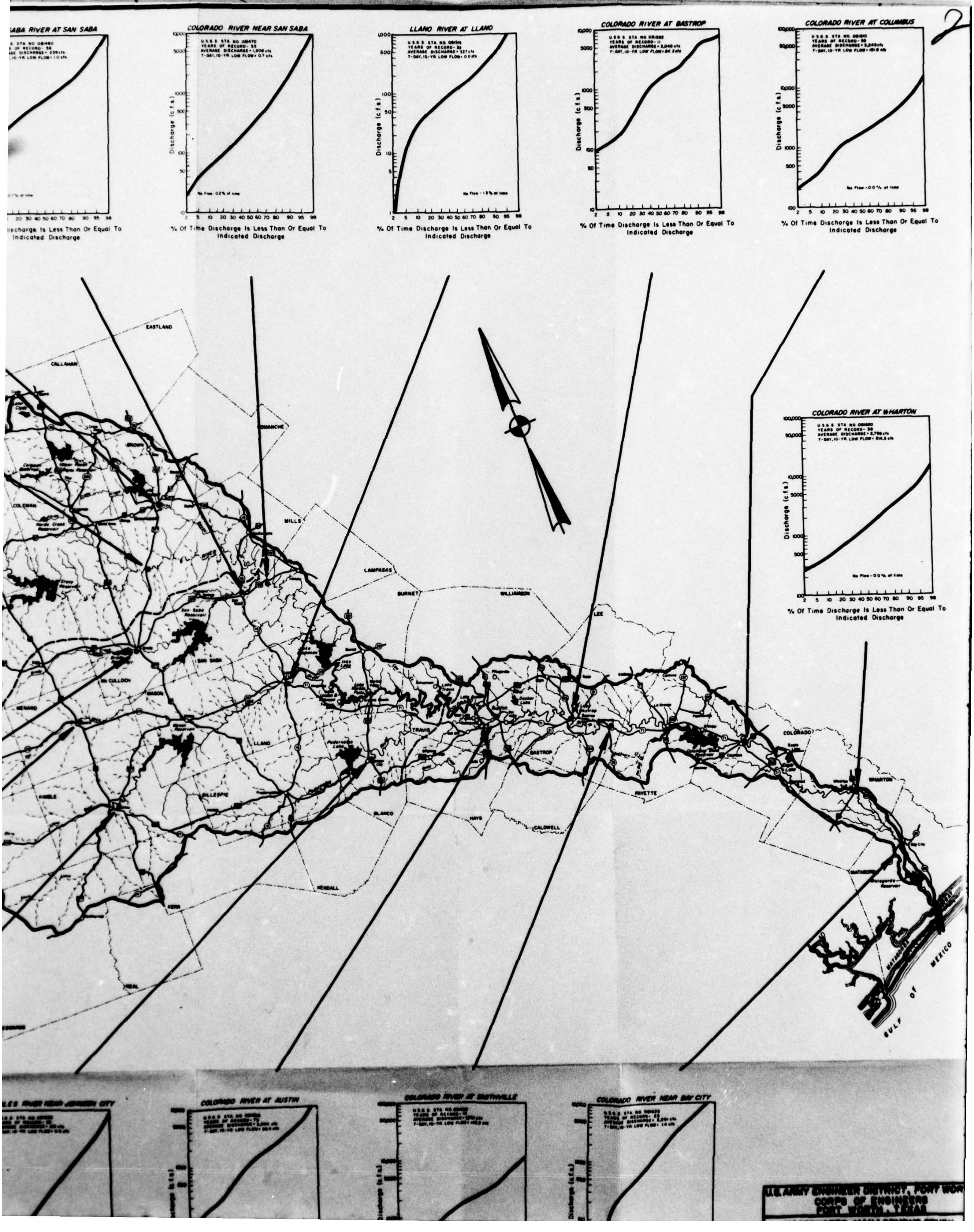
Stream	U.S.G.S. Station Number	Recurrence Intervals 1-Year	2-Year	5-Year	10-Year
COLORADO RIVER	081210	0.0	0.0	0.0	0.0
(main stem)	081240	0.0	0.0	0.0	0.0
	081265	12.5	0.5	0.0	0.0
	081380	43.4	0.1	0.0	0.0
	081470	251.9	44.0	19.9	0.7
	081580	1563.3	173.1	58.1	39.4
	081592		124.0	84.6	84.3
	081595	1598.6	389.4	172.2	143.3
	081610	1891.4	589.1	207.6	181.8
	081620	1320.7	516.6	273.9	214.3
	081625	890.0	16.7	1.8	1.4
BEALS CREEK	081238	0.0	0.0	0.0	0.0
CONCHO RIVER	081360	17.1	1.0	0.2	0.1
	081365	24.3	0.0	0.0	0.0
PECAN BAYOU	081435	4.2	0.1	0.0	0.0
SAN SABA RIVER	081445	23.9	1.9	0.0	0.0
	081450*	0.1	0.0	0.0	0.0
	081460	150.6	25.6	8.1	1.0
LLANO RIVER	081500	109.0	44.0	26.4	13.6
	081515	116.9	23.3	0.1	0.0
PEDERNALES RIVER	081535	24.7	3.3	0.0	0.0

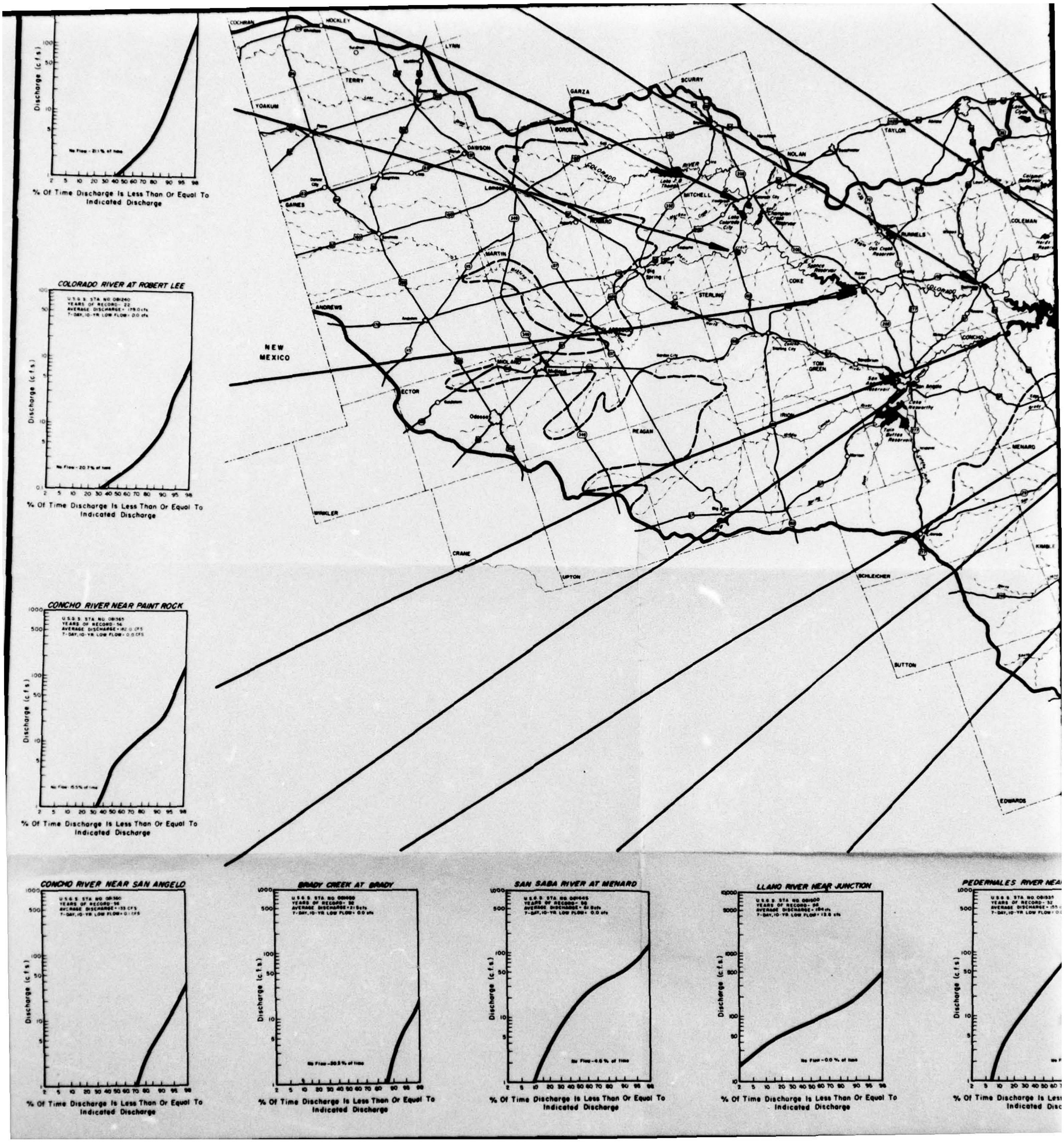
Located on Brady Creek.



COLORADO RIVER AT COLORADO CITY
COLORADO RIVER AT BALLINGER
COLORADO RIVER AT WINCHELL
PECAN BAYOU AT BROWNWOOD
SAN SABA RIV
BEALS CREEK NEAR WESTBROOK
COLORADO RIVER AT ROBERT LEE
CONCHO RIVER NEAR PAINT ROCK
CONCHO RIVER NEAR SAN ANGELO
BRADY CREEK AT BRADY
SAN SABA RIVER AT MENARD
LLANO RIVER NEAR JUNCTION
PEDERNALES R
Discharge (c f s)
% Of Time Discharge Is Less Than Or Equal To Indicated Discharge
NEW MEXICO
COCHRAN
HOCKLEY
LYNN
YOAKUM
TERRY
GARZA
SCURRY
BORDEN
DAWSON
GAINES
NOLAN
TAYLOR
MITCHELL
COLORADO
RIVER
MARTIN
ANDREWS
STERLING
COKE
RUNNELS
COLEMAN
CONCHO
TOM GREEN
ECTOR
REAGAN
WINKLER
CRANE
UPTON
SCHLEICHER
SUTTON
MENARD
EDWARDS

2


SABA RIVER AT SAN SABA
COLORADO RIVER NEAR SAN SABA
U.S.G.S. STA NO 081470
YEARS OF RECORD- 53
AVERAGE DISCHARGE = 1,506 cfs
7-DAY, 10-YR LOW FLOW = 0.7 cfs
No Flow - 0.2% of time
LLANO RIVER AT LLANO
U.S.G.S. STA NO 081510
AVERAGE DISCHARGE = 527 cfs
7-DAY, 10-YR LOW FLOW = 0.0 cfs
COLORADO RIVER AT BASTROP
U.S.G.S. STA NO 081592
YEARS OF RECORD- 11
AVERAGE DISCHARGE = 2,040 cfs
COLORADO RIVER AT COLUMBUS
No Flow - 0.0 % of time
COLORADO RIVER AT WHARTON
U.S.G.S. STA NO 081620
AVERAGE DISCHARGE = 2,790 cfs
7-DAY, 10-YR LOW FLOW = 214.3 cfs
No Flow - 0.0 % of time
Discharge (c.f.s.)
% Of Time Discharge Is Less Than Or Equal To Indicated Discharge
EASTLAND
CALLAHAN
COMANCHE
BROWN
COLEMAN
MILLS
LAMPASAS
BURNET
WILLIAMSON
LEE
SAN SABA
McCULLOCH
MASON
MENARD
LLANO
TRAVIS
BASTROP
GILLESPIE
KIMBLE
BLANCO
HAYS
CALDWELL
FAYETTE
COLORADO
WHARTON
MATAGORDA
KENDALL
KERR
REAL
GULF OF MEXICO
COLORADO RIVER AT AUSTIN
COLORADO RIVER NEAR BAY CITY
CORPS OF ENGINEERS



Discharge (c f s)
No Flow - 21.1% of time
% Of Time Discharge Is Less Than Or Equal To Indicated Discharge
COLORADO RIVER AT ROBERT LEE
U.S.G.S. STA NO 081240
YEARS OF RECORD - 22
AVERAGE DISCHARGE - 179.0 cfs
7-DAY, 10-YR LOW FLOW - 0.0 cfs
No Flow - 20.7% of time
CONCHO RIVER NEAR PAINT ROCK
U.S.G.S. STA NO 081365
YEARS OF RECORD - 56
AVERAGE DISCHARGE - 182.0 CFS
7-DAY, 10-YR LOW FLOW - 0.0 CFS
CONCHO RIVER NEAR SAN ANGELO
BRADY CREEK AT BRADY
U.S.G.S. STA NO 081450
YEARS OF RECORD - 52
7-DAY, 10-YR LOW FLOW - 0.0 cfs
SAN SABA RIVER AT MENARD
U.S.G.S. STA NO 081445
YEARS OF RECORD - 56
7-DAY, 10-YR LOW FLOW - 0.0 cfs
No Flow - 4.5% of time
LLANO RIVER NEAR JUNCTION
U.S.G.S. STA NO 081500
YEARS OF RECORD - 56
AVERAGE DISCHARGE - 184 cfs
7-DAY, 10-YR LOW FLOW - 12.6 cfs
No Flow - 0.0% of time
PEDERNALES RIVER NEA
U.S.G.S. STA NO 081535
YEARS OF RECORD - 32
NEW MEXICO
COCHRAN
HOCKLEY
LYNN
TERRY
YOAKUM
GARZA
SCURRY
BORDEN
DAWSON
NOLAN
TAYLOR
COLORADO
MITCHELL
GAINES
HOWARD
COLEMAN
RUNNELS
MARTIN
STERLING
COKE
ANDREWS
CONCHO
TOM GREEN
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IRION
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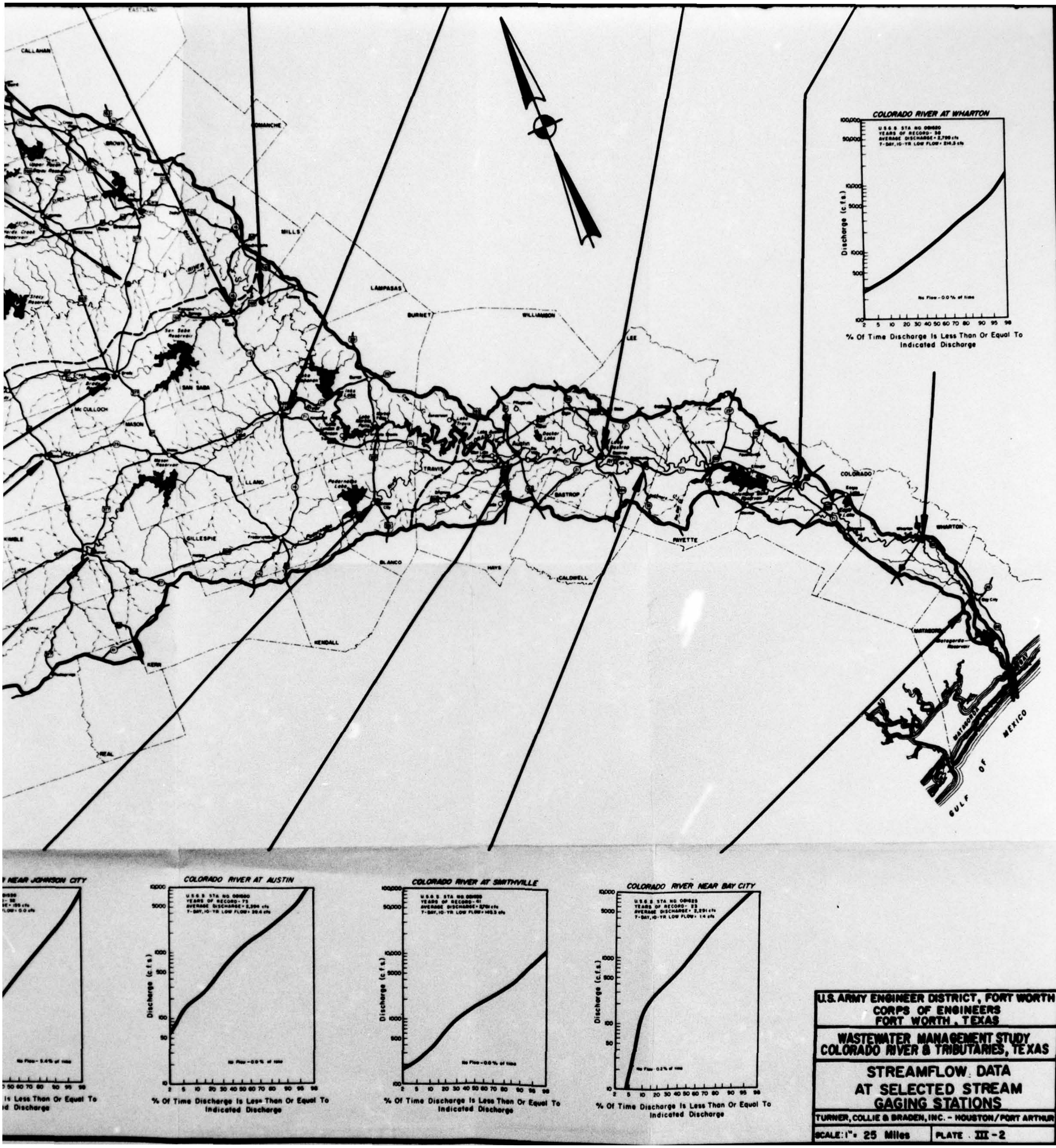
WINKLER
CRANE
UPTON
SCHLEICHER
KIMBLE
SUTTON
EDWARDS



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

STREAMFLOW DATA
AT SELECTED STREAM
GAGING STATIONS

TURNER, COLLIE & BRADEN, INC. - HOUSTON/FORT ARTHUR

SCALE: 1" = 25 Miles | PLATE III-2

Beals Creek enters the River at river mile 769.8 approximately 3.7 miles upstream from Robert Lee Dam, which was completed in December 1968. Since that date, the flow as recorded at the gaging station at Robert Lee (081240) has been fully regulated by E.V. Spence Reservoir. A 50th percentile flow condition of 0.2 cfs has been experienced at this station since closure of the dam. Although the average discharge during the period of record has been 179 cfs, approximately 20.7 percent of the time there is no flow in the stream. The seven-day, ten-year low flow prior to the closure of the dam was zero.

The gaging station at Ballinger (081265) is one of the oldest stations in the Basin. The flow at this station is partially regulated by numerous diversions and by five major upstream reservoirs. The contributing drainage area at this point amounts to 5,240 square miles, the runoff from which has accounted for the major portion of the average discharge of 322 cfs. There is flow in the stream about 89 percent of the time as compared to 79.3 percent upstream at the Robert Lee station. Further, 50 percent of the time when there is flow, it is at least 7.2 cfs. However, even with the improved flow condition, the seven-day, ten-year low flow is zero.

Approximately one hundred miles downstream at Winchell (081380) there is flow in the river about 94 percent of the time--that is, there is no flow in the stream only 21 days out of the average year. The average discharge is quoted as 601 cfs during the period of record. The 50th percentile flow condition is 57 cfs, about eight times greater than recorded at Ballinger. Further, the 25th percentile is slightly less than 14 cfs. As upstream, the seven-day, ten-year low flow was zero. The proposed Stacy Reservoir will undoubtedly have a marked effect on flow at this station. Additional data on streamflow in that segment of the river downstream from the proposed Stacy dam site are being gathered near Stacy (081367).

The average discharge at San Saba (081470), 1,308 cfs, is more than double that measured at Winchell. A no-flow condition exists in the stream only 0.2 percent of the time--an average of one day a year. Coupled with this increased regularity of flow is an increase in the 50th percentile flow to 270 cfs. The sustained nature of flow at this station is further accentuated by the fact that there is a seven-day, ten-year low flow amounting to 0.7 cfs, or about 0.45 mgd. It should be noted that two of the principal tributaries, the San Saba River and Pecan Bayou, intercept the main stem of the Colorado River between Winchell and San Saba. In fact, the confluence of the San Saba and Colorado is 5.2 miles upstream from the gaging station at San Saba.

Streamflow within the next major segment (about 180 river miles) is primarily regulated by the Highland Lakes system and the City of Austin's Town Lake. From the farthest upstream reservoir in the system (Lake Buchanan) to Town Lake, virtually the entire length of the river is occupied by reservoirs. The Llano and Pedernales Rivers discharge into the Colorado River in this reach of the river, at river miles 400.3 and 354.6, respectively. Due to the complex network of reservoirs in this segment of the river, there are no streamflow gaging stations on the main stem. The Highland Lakes are owned and operated by the Lower Colorado River Authority (LCRA). The LCRA utilizes a sophisticated model in the intricate operation of the water releases in the chain of lakes to meet the various contracted needs, ranging from hydroelectric power generation to supplying water for irrigation in the coastal areas.

The gaging station at Austin (081580) is located about 1.4 miles downstream from Longhorn Dam (which backs up into Town Lake). The station, the oldest in the Basin, has been measuring flows in the river for 73 years. While there are sixteen major reservoirs above the station with a total combined capacity of 4,642,000 acre-feet, the flow at the station is primarily regulated by Lake Travis. Minimum flow recorded at the station through water year 1971 has been 13 cfs and the average flow during the 73-year period has been 2,394 cfs. The flow duration relationship at this station has been regulated to various degrees with the closure of each successive dam upstream. The curve, presented in Plate III-2, reflects the overall flow-duration relationships monitored at this station. As is seen, the 50th percentile flow condition at this station is 1,200 cfs. The seven-day, ten-year low flow of 39.4 cfs delineates the sustained nature of flow in the river at this point. As will be seen in the remainder of the analysis, there is sustained flow in the river from this station to the mouth at the Gulf of Mexico.

Flow below Austin is supplemented somewhat by the return flow from the Austin municipal wastewater treatment plants, which amounted to 24,450 acre-feet, (33.8 cfs) or 21.8 mgd, in water-year 1971. There are also numerous direct diversions from the river below Austin. A prime example of this is diversions by the LCRA and the City of Austin to maintain the water levels in Lake Bastrop and Decker Lake, respectively. This amounted to 6,048 acre-feet for Lake Bastrop and 2,140 acre-feet for Decker Lake during water-year 1971. As seen in Plate III-2, the average flow at Bastrop (081592) has been recorded as 2,040 cfs. The sustained flow 50 percent of the time is 1,400 cfs, and the low flow condition at this location is 84.3 cfs.

Below Bastrop, the proliferation of diversions for municipal, industrial, and irrigation purposes continues. The increased use of high-capacity pumps results in increased pumping from the river to satisfy irrigation needs. Coincident with this increased use of surface water has been an increase in the amount of municipal return flow to the river. This is readily apparent by reviewing discharge records of those municipal treatment facilities which discharge to the river.

The streamflow continues to increase proportionately downstream until Bay City (081625) where there is a decided decrease in average streamflow. In fact, no flow has been recorded about 0.2 percent of the time--an average of just one day a year. The reduction in flow, which is particularly apparent during periods of low flow, is caused by a substantial diversion by the LCRA just upstream from the station for irrigation. The LCRA has also installed an inflatable dam as part of the diversion apparatus. The dam is inflated during periods of low flow to prevent saltwater intrusion and to back up the water in the river so that diversion for irrigation can be effected.

Beals Creek.

Beals Creek, the first major tributary to enter the Colorado River, rises in the Natural Salt Lake. The creek drains a large portion of the so-called noncontributing portion of the Basin. Springs provide what base flow there may be in the creek; however, even this is usually lost within a very short distance due to seepage and evaporation. Significant runoff usually occurs following high intensity rainfall, but even then only a small portion of the runoff reaches the stream. Seepage, several natural salt lakes, and numerous playa lakes regulate runoff from the contributing portion of the Basin. Thus, the streamflow can at best be termed intermittent.

There are two gaging stations on Beals Creek, and data from these stations give more explicit insight into flow conditions in the upper and lower reaches of the creek. Records from the station (08123650) above Big Spring show that there is flow in the creek only about 18 percent of the time in an average year, and when there is flow, 94 percent of the time it is no greater than 1.0 cfs. The flow below Big Spring is supplemented by 2.35 mgd (3.63 cfs) of return flow from the Big Spring wastewater treatment plant. However, approximately 47 miles downstream (station 081238) from the discharge of the Big Spring plant, there is flow in the creek more than 80 percent of the time. The discharge 50 percent of this time does not exceed 1.3 cfs, and only about 21 percent of the time

does the flow equal or exceed 3.63 cfs. Of course, the seven-day, ten-year low flow at both stations is 0.0 cfs.

Concho River.

The Concho River, the shortest of the major tributaries, begins at the confluence of the North and South Concho Rivers east of San Angelo in Tom Green County. For purposes of this analysis, the Basin has been divided into two parts: the upper Basin (above the source) and the lower Basin (from source to Colorado River).

The upper Basin encompasses approximately 5,300 square miles, of which approximately 24 percent is noncontributing. The area is drained by five springfed streams which head in the Edwards Plateau. Base flow in the streams is predominately spring flow, as surface runoff usually occurs only during high intensity rainfall of fairly long duration. The spring flow varies from stream to stream. The streamflow in Dove Creek near Knickerbocker is totally spring flow. Based on records for the period 1931-1960, the maximum daily potential spring flow to the South Concho (as measured at Christoval) was approximately 24 cfs. As seen in Table III-2, the flow in the streams is regulated to various degrees by numerous diversions for municipal, irrigation, and recreational purposes.

Twin Buttes Reservoir, San Angelo Reservoir, and Lake Nasworthy intercept the flow of all those streams in the upper Basin. These reservoirs were completed respectively in 1952, 1948, and 1962. With the completion of each reservoir, the flow in the Concho River became more regulated, such that since 1962 the flow has been completely regulated by these reservoirs. The determination of exactly what effect these reservoirs have had on streamflow has been hampered due to the fact that during the period 1962-1968, runoff in the Basin was almost zero.

The duration curves for those gaging stations at San Angelo (081360) and near Paint Rock (081365) are for the period 1962-1969. As seen in Plate III-2, there has been flow at the San Angelo station virtually 100 percent of the time, while flow has been recorded at Paint Rock only 84.5 percent of the time. However, during the period 1962-69, there has been a flow of about 4.2 cfs 50 percent of the time at the Paint Rock station, whereas a flow equal to or greater than 1.0 cfs was recorded only 73 percent of the time at San Angelo.

In summary, it is reemphasized that the flow duration information for the period 1962-69 includes a period (1962-68) of unusually low runoff in the Basin when rainfall was significantly lower than the mean annual

TABLE III - 2

STREAMFLOW IN SELECTED TRIBUTARIES TO CONCHO RIVER

Station No.	Name	Period of Record	Average Discharge (cfs)	Remarks
08134000	North Concho River near Carlsbad	1924-68	39.1	Flow affected by pumping above station – no flow in the stream 26.1% of the time.
081284000	Middle Concho River above Tankersley	1961-71	7.94	Low flow affected by diversions for irrigation.
08129300	Spring Creek above Tankersley	1960-71	10.5	Flow affected by many small irrigation diversions.
08130500	Dove Creek near Knickerbocker	1960-71	10.3	Springflow only – flow partly regulated by diversion from two small channel dams upstream and by many small diversions for irrigation.
081280	South Concho River at Christoval	1930-69	31.7	Low flow materially affected by diversions to South Concho Irrigation Co. canal 600 feet upstream from station. However, there has been flow 99.9+% of the time.

rainfall. Consequently, the flow duration curves do not truly represen the probable long-term flow conditions in the stream. However, long-term data should not result in any significant variation in the shape of the curves, but rather a gradual increase in the overall flow-duration values.

Pecan Bayou

The streamflow in Pecan Bayou is minimal and sporadic above Lake Brownwood. Lake Clyde stores a portion of the runoff in the upper portion of the drainage area while Lake Coleman and Hords Creek Reservoir regulate the flow in Jim Ned Creek and Hords Creek--the two primary tributaries of Pecan Bayou. The proposed Upper Pecan Bayou Reservoir should tend to regulate even further flow in the middle reach of the Bayou. In addition to the major reservoirs, there are numerous small reservoirs, ponds, and 111 floodwater-retarding structures, with a combined capacity of 137,773 acre-feet below the flood-spillway crest, which regulates flow in the drainage area.

Below Lake Brownwood, Pecan Bayou discharges at an average rate of 152 cfs near Brownwood (081435). However, further examination of the flow data at this station revealed that 7.1 percent of the time, about 26 days of an average year, there is no flow in the stream. The flow does not exceed 2.0 cfs (50 percent of the time). This is very interesting when one considers that the City of Brownwood discharges effluent from its wastewater treatment plant into the Bayou just below this point at an average rate of 2.2 mgd (3.4 cfs.). Thus, on an average, the streamflow below the discharge of the treatment facility is approximately 63 percent effluent. However, even with this high percentage of effluent, there have been no known serious pollution problems in the stream below the discharge point.

Streamflow below Brownwood is supplemented by runoff from approximately 450 square miles. In 1967, the USGS established a gaging station on Pecan Bayou near Mullin (081436), ten miles upstream from the Colorado River. The mean annual discharge at this station has ranged from 430 cfs in water-year 1968 to 60.3 cfs in water-year 1971. This brief period of record does not permit completion of any appropriate flow-duration and frequency information.

San Saba River.

The Texas Water Rights Commission has granted permits to divert water from the San Saba River to irrigate 3, 338 acres upstream from Menard. According to the Texas Water Development Board, approximately 2, 900 acres in Menard County and 122 acres in Schleicher County were irrigated by surface water in 1969. The diversions have a notable effect on the streamflow, especially during periods of low flow. One of the primary diversions in the upper reach is Noyes Canal in Menard. Since 1924, water has been diverted at an average rate of 13.4 cfs (9, 710 acre-feet per year) to the canal to irrigate land near Menard.

Although there is no gaging station upstream from these diversions, data from a downstream station (081445) in Menard infer what effect these diversions can have on low flow. The average discharge at the station, which is four miles downstream from Noyes Canal, is 61.8 cfs. Half of the time when there is flow in the river it is equal to or less than 18 cfs. A closer scrutiny and comparison of the discharge data for Noyes Canal and the subject station (081445) show that on numerous occasions diversions are recorded for the canal with a resultant no-flow condition recorded at the river station. Thus, one of the reasons for no flow in the stream approximately 17 days in an average year (4.6 percent of the time) is the 100 percent diversion of flow into the irrigation canal.

With the exception of Brady Creek, which enters the San Saba at river mile 46.7, there are no known diversions or other factors which affect streamflow in the middle reach of the river. The average discharge of the Creek at Brady (081450) is 21.5 cfs. The flow at this station has been largely regulated since 1963 by Brady Creek Reservoir. In general, the dam has resulted in a smaller flow in the Creek; however, the percent of the time when there is no flow has decreased from 41.3 to 30.3 percent. As seen in Plate III-2, approximately 86 percent of the time the flow is less than or equal to 1 cfs. This condition existed approximately 77 percent of the time prior to the construction of the reservoir. The streamflow below the station was supplemented by return flow (322 acre-feet or 0.44 cfs) in water-year 1971 from the Brady wastewater treatment plant.

Extensive diversion for irrigation also affects low flow in the lower reach of the river. However, according to flow records (08146000) at San Saba, 16.6 miles upstream from the confluence of the San Saba and Colorado Rivers, there is flow in the River 99 percent of the time. The seven-day, ten-year low flow is 1.0 cfs. The average discharge at

the station is 239 cfs, and 50 percent of the time the flow is at least 83 cfs. The flow is partly regulated by Brady Creek Reservoir and numerous floodwater-retarding structures upstream. The flow will be even more regulated upon completion of the proposed San Saba Reservoir.

Llano River.

The Llano River, a spring-fed stream, heads at the confluence of the North and South Llano Rivers northeast of Junction. The river crosses several significant faulted areas throughout its traverse. In fact, part of the low flow in the river disappears into various formations between Junction and Llano. Numerous irrigation diversions occur in the upper part of the river. This is evidenced by the fact that in 1969, 3,571 acre-feet were diverted for irrigation in Kimble and Sutton Counties. Less than one-third of that amount, 1,018 acre-feet, was diverted for irrigation in the remainder of the drainage area during that year. The Llano River is also the source of the municipal water supply for the City of Llano. Last year the City of Llano's average water consumption was 0.606 mgd, or about 1.9 acre-feet per day. There is no major reservoir in the Llano River Basin.

Even with the numerous diversions and seepage into faulted formation, the Llano River is virtually a perennially-flowing stream, as witnessed by the flow records of the gaging stations on the river. The initial station (081500) east of Junction, which has an average discharge of 184 cfs, has a seven-day, ten-year low flow of 13.6 cfs throughout the 56 years of record. The flow is at least 80 cfs 50 percent of the time. Some indication as to the flow between Junction and Llano is being provided by the recently-established gaging station (081507) near Mason. The station was established in 1968 and, since its installation, the minimum flow recorded has been only 17 cfs through water-year 1971. As seen in Plate III-2, at Llano (station 081515) the river discharges at a rate of at least 114 cfs 50 percent of the time. However, at this station there is no flow in the stream 1.3 percent of the time, and the seven-day, ten-year low flow is zero. This peculiar situation is somewhat clarified by a further review of the flow records of this station. According to the records, there has been measurable flow at this station except during the years of drought; specifically, 1952-56 (approximately 128 days of no flow) and 1964 (only 19 days of no flow).

Pedernales River.

The Pedernales River meanders approximately 123 miles from its source in the Edwards Plateau to Lake Travis on the Colorado River. There are currently no major reservoirs which affect streamflow in the river. However, the construction of the proposed Pedernales Reservoir could significantly affect flow in the stream. Streamflow is influenced by numerous diversions for municipal and irrigation needs. This is particularly evident in that portion of the drainage area in Gillespie County where, in 1969--according to the TWDB--1,019 acre-feet were diverted from the Pedernales to irrigate 1,002 acres. Municipal return flow, 822 acre-feet from Fredericksburg in water-year 1971, tends to supplement flow in the river.

Currently, there is only one streamflow gaging station (081535) located in the Pedernales drainage area. It is located on the Pedernales River near Johnson City, and the average discharge of the river at the station is 155 cfs. The seven-day, ten-year low flow recorded at the station is 0.0 cfs. There is no flow in the stream only 3.4 percent of the time, or an average of 12 days a year. Furthermore, of the 96.6 percent of the time when there is flow, 50 percent of the time the flow is at least 31 cfs.

Development.

There are currently 21 major reservoirs with capacities of 5,000 acre-feet or more in the Colorado River Basin. With a total capacity of 5,303,510 acre-feet, the reservoirs range in capacity from 8,640 to 1,950,000 acre-feet. Locations of these reservoirs and pertinent data are shown on Plate III-2 and on Table III-2a, respectively.

Champion Creek, Colorado City, J.B. Thomas, E.V. Spence, and Oak Creek Reservoirs are the major reservoirs in Zone 1 (see Figure III-1). Lake Colorado City and Champion Creek Reservoirs are owned and operated by Texas Electric Service Company. The two reservoirs are interconnected and water is periodically withdrawn from Champion Creek to serve as make-up water for Colorado City. Lake Colorado City is primarily used for cooling purposes--687,878 acre-feet in water-year 1971. There were 708 acre-feet diverted from the lake to the City of Colorado City for municipal needs in water-year 1971. Oak Creek

TABLE III - 2A

EXISTING AND PROPOSED MAJOR RESERVOIRS IN THE COLORADO RIVER BASIN

Zone	Reservoir	Location	Stream	Owner	Purpose	Elevation[1]	Incremental capacity (acre-feet)	Area (acres)	2020 yield[2] (acre-feet per year)	Use[3]
1	J. B. Thomas (with Bull Creek diversion)	16 mi. SW of Snyder	Colorado River	Colorado River Municipal Water District	Sediment	–	31,560	–	–	M, I, R
					Conservation	2,258.0	172,050	7,820	15,000	
1	Colorado City	6 mi. SW of Colorado City	Morgan Creek	Texas Electric Service Co.	Sediment	–	9,400	–	–	M, I, CW
					Conservation	2,070.1	21,800	1,655	4,100	
1	Champion Creek	7 mi. S of Colorado City	Champion Creek	Texas Electric Service Co.	Sediment	–	5,750	–	–	M, I
					Conservation	2,083.0	36,750	1,560	4,100	
1	E. V. Spence	2 mi. W of Robert Lee	Colorado River	Colorado River Municipal Water District	Sediment	–	34,000	–	–	M, I
					Conservation	1,898.0	454,700	15,000	60,000	
1	Oak Creek	5 mi. SE of Blackwell	Oak Creek	City of Sweetwater	Sediment	–	4,820	–	–	M, I, CW
					Conservation	2,000.0	34,540	2,375	3,400	
2	Twin Buttes	8 mi. SW of San Angelo	Middle and South Concho Rivers	U. S. Government	Sediment	–	14,270	–	–	M, I, Ir, R, FC
					Conservation	1,940.2	171,900	9,400	28,900	
					Flood Control	1,969.1	454,400	22,700	–	
2	Lake Nasworthy	6 mi. SW of San Angelo	South Concho River	City of San Angelo	Sediment	–	–	–	–	M, I, Ir, R, CW
					Conservation	1,872.2	12,390	1,596	–	
2	San Angelo	3 mi. NW of San Angelo	North Concho River	U. S. Government	Sediment	–	12,220	–	–	M, I, Ir, R, FC
					Conservation	1,908.0	108,900	5,440	11,000	
					Flood Control	1,938.5	277,200	12,700	–	
2	Stacy*	Just below confluence of Colorado and Concho Rivers	Colorado River		Sediment	–	50,000	–	–	M, I, Ir, FC
					Conservation	1,564.0	650,000	22,700	107,000	
					Flood Control	1,583.0	650,300	37,700	–	
2	Hords Creek	5 mi. NW of Valera	Hords Creek	U. S. Government	Sediment	–	170	–	–	M, I
					Conservation	1,900.0	8,470	510	1,000	
2	Coleman (Jim Ned Creek)	14 mi. N of Coleman	Jim Ned Creek	U. S. Government	Sediment	–	3,080	–	–	M, I
					Conservation	1,717.0	36,940	2,030	7,200	
2	Upper Pecan Bayou*	17 mi. NNE of Coleman	Pecan Bayou		Sediment	–	10,100	–	–	FC
					Conservation	1,837.0	93,500	8,030	4,300	
					Flood Control	1,853.0	102,700	9,160	–	
2	Brownwood	8 mi. N. of Brownwood	Pecan Bayou	Brown County Water Improvement District No. 1	Sediment	–	10,200	–	–	M, I, Ir
					Conservation	1,424.6	133,200	7,300	27,500	
2	Brady Creek	3 mi. W of Brady	Brady Creek	City of Brady	Sediment	–	520	–	–	M, I
					Conservation	1,743.0	28,590	2,020	8,800	
3	Buchanan	11 mi. W of Burnet	Colorado River	Lower Colorado River Authority	Sediment	–	235,150	–	257,100	M, I, Ir, P, R
					Conservation	1,020.5	756,850	23,300	–	

*Proposed reservoirs.

[1] Feet above mean sea level datum.

[2] Does not include return flows.

[3] Uses: M–Municipal; I–Industrial; Ir–Irrigation; CW–Cooling Water for power plant; P–Hydroelectric power generation; FC–Flood Control; R–Recreation.

TABLE III - 2A (Cont'd.)

Zone	Reservoir	Location	Stream	Owner	Purpose	Elevation[1]	Incremental capacity (acre-feet)	Area (acres)	2020 yield[2] (acre-feet per year)	Use[3]
3	Inks	10 mi. W of Burnet	Colorado River	Lower Colorado River Authority	Sediment Conservation	– 888.0	-- 17,000	– 830	– –	P, R
3	Lyndon B. Johnson	4 mi. SW of Marble Falls	Colorado River	Lower Colorado River Authority	Dead Conservation	– 825.0	21,200 117,300	– 6,200	– –	P, R
3	Marble Falls	In Marble Falls	Colorado River	Lower Colorado River Authority	Sediment Conservation	– 738.0	– 8,760	– 780	– –	P, R
3	Travis	13 mi. NW of Austin	Colorado River	Lower Colorado River Authority	Sediment Conservation Flood Control	– 681.1 714.1	-- 1,172,000 778,000	– 18,930 29,000	– 336,300 –	M, I, Ir, R, P, FC
3	Lake Austin	In Austin	Colorado River	Lower Colorado River Authority	Sediment Conservation	-- 492.8	1,000 20,000	– 1,830	– –	M, P, R
4	Decker Creek		Decker Creek	City of Austin	Storage	555.0	33,940	1,269	–	CW
4	Bastrop		Spicer Creek	Lower Colorado River Authority	Storage	450.0	16,590	906	–	CW, R
4	Columbus Bend*	2 mi. W of Columbus	Colorado River	–	Sediment Conservation Flood Control	– 238.8 250.0	88,100 396,200 481,700	– 29,500 39,900	– 123,200 –	M, I, Ir, FC
4	Eagle Lake		Colorado River (off channel)	Lakeside Irrigation Company	Storage	170.0	9,600	1,200	–	Ir
4	Matagorda*	4 mi. N of Matagorda	Colorado River	–	Sediment Conservation	– 21.0	28,600 61,400	– 12,300	– 46,000	M, I, Ir

Reservoir, owned by the City of Sweetwater, is a multi-purpose reservoir. It provides municipal water supplies to the cities of Sweetwater, Blackwell, Bronte, and Robert Lee, as well as cooling water for the Oak Creek Power Station which is owned by West Texas Utilities Company.

Lake J. B. Thomas and E. V. Spence Reservoirs are owned and operated by the Colorado River Municipal Water District. They are part of the District's extensive water supply network. In 1972, 23,069 acre-feet (7.5 billion gallons) and 22,681 acre-feet (7.4 billion gallons) were withdrawn, respectively, from Lake J. B. Thomas and E. V. Spence Reservoir for municipal and industrial purposes. Big Spring, Odessa, Snyder, Midland, San Angelo, and Stanton are currently supplied water from the reservoirs. Further, 3,014 acre-feet of brackish water, diverted from the river by the District, were sold for use in oilfield water flooding.

The only current Basin import of surface water is located in Zone 1. The Canadian River Aqueduct, owned by the Canadian River Municipal Water Authority, from Lake Meredith, is currently providing about 2,734 acre-feet a year (2.441 mgd) to the cities of Lamesa and Brownfield. The transmission facilities have a maximum capacity of 4.94 mgd, with 2.47 mgd allocated to each city.

Three of the seven major reservoirs in Zone 2 are located near San Angelo. The largest, Twin Buttes, was constructed by the U. S. Bureau of Reclamation for flood control, conservation storage, recreation and irrigation. San Angelo Reservoir is a U. S. Army Corps of Engineers project constructed primarily for flood control. To date, due to drought conditions, neither reservoir has impounded as much water as anticipated. The last reservoir adjacent to San Angelo is Lake Nasworthy, which is owned by the City of San Angelo and operated for municipal water supply.

Brady Creek Reservoir, in McCulloch County, was constructed to provide water for the City of Brady. Through water-year 1971, the City has not withdrawn water from the reservoir for municipal needs. Coleman and Hords Creek Reservoir are primarily water supplies for the City of Coleman. Lake Brownwood, on Pecan Bayou, is operated by the Brown County Water Improvement District No. 1, In water-year 1971, 13,467 acre-feet were directed for municipal (5,683 acre-feet), industrial (3,633 acre-feet), and irrigation (4,151 acre-feet) needs.

The Highland Lakes, owned and operated by the Lower Colorado River Authority, are located in Zone 3. In downstream order, they are Lake Buchanan, Inks Lake, Lake Lyndon B. Johnson, Lake Marble Falls, Lake Travis, and Lake Austin. Hydroelectric power generation facilities are

installed at each reservoir, and Travis provides significant flood and conservation storage. Significant flood control is afforded by Lake Travis. Water from the Highland Lakes is also used to serve various municipal and industrial needs as well as coastal irrigators. Below Lake Austin, the City of Austin has built Longhorn Dam creating Town Lake. Water from the lake is used as cooling water for the City's Holley Street and Seaholm power plants.

Reservoirs in Zone 4 include Lake Bastrop, Decker Lake, and Eagle Lake. Lake Bastrop and Decker Lake, owned respectively by the LCRA and the City of Austin, are off-channel reservoirs which provide cooling water for thermoelectric plants. They are more or less closed systems; that is, they seldom discharge except during periods of exceptionally high rainfall. During water-year 1971, 5,451 acre-feet and 105,834 acre-feet were diverted from Lake Bastrop and Decker Lake, respectively, for cooling purposes.

The remaining reservoir in Zone 4 (Eagle Lake) constructed in 1900, is the oldest reservoir in the Basin and one of the oldest major reservoirs in Texas. It is a privately-owned off-channel reservoir with a capacity of 9,600 acre-feet. Floodwater is pumped from the Colorado River and stored in the lake for use in irrigation. The Lakeside Irrigation Company, owner of Eagle Lake, provides water to some of the oldest irrigation systems in the State. There were 62,058 acre-feet of water from Eagle Lake used to irrigate 14,401 acres during water-year 1971.

Coupled with this extensive physical surface water development has been an ever-increasing diversion of streamflow for various needs, primary of which is irrigation. In fact, presently the Colorado River Basin is one of the three Basins in the State which is currently over-allocated. The Texas Water Rights Commission is the State agency which is assigned the task of adjudicating the surface waters in the State. In the adjudication, the Commission will review the following declarations of surface water use:

Certified Filings	- declaration of existing use filed in compliance with 1913 statute regarding water appropriation throughout the State.
Permit	- appropriations for water use approved in accordance with the 1913 statute.
Claim	- declaration of riparian claim.

Application	- request for authorization to impound or divert streamflow which has been granted

There are currently about 1,200 claims, permits, certified filings, and applications within the Colorado River Basin on file with the Commission. Some idea as to the magnitude of these declarations on the main stream of the Colorado River and its primary tributaries are shown in Table III-3.

Surface water availability and dependability have been affected by the continuing implementation of drainage improvements throughout the Basin. In 1966, there were 242 flood-water retarding structures completed or contracted in the Basin. As of 1966, approximately 9.0 of the planned 38.03 miles of channel improvement throughout the Basin was completed or in progress. On-farm drainage systems improvements, land leveling, field drains, etc. have had an effect on surface water runoff in portions of the Basin.

Table III-3

Surface Water Declarations[1] on Selected Streams in the Colorado River Basin (acre-ft./yr.)

Streams	Annual Withdraw
Colorado River	3,173,912
Concho River	12,945
Middle	165
North	1,063
South	9,634
Pecan Bayou	7,766
San Saba River	37,593
Llano River	4,703
Middle	279
North	1,297
South	3,099
Pedernales River	5,651

[1] Taken from the records of the Texas Water Rights Commission (10-72)

Ground Water.

Resources.

Ground water constitutes a major source of water supply in the Colorado River Basin. The primary sources of ground water are the nine major and minor aquifers (Plate III-3) within the Basin. Of the tremendous volumes of ground water in the Basin, it has been estimated that the usable (quality-wise) and economically recoverable perennial yield is approximately 538,700 acre-feet.

The five major aquifers--that is, an aquifer which yields large quantities of water in a comparatively large area of the State--within the Basin are the Ogallala, Edwards-Trinity (Plateau), Edwards (Balcones Fault Zone), Carrizo-Wilcox, and the Gulf Coast Aquifers. The Santa Rosa, Ellenburger-San Saba, Edwards-Trinity (High Plains), and Hickory Aquifers are the minor aquifers in the Basin. Several smaller aquifers such as the Chine Formation, Alluvium, etc. provide limited quantities of water for domestic and livestock supply and in some instances, for municipal, industrial, and irrigation needs.

A summary of the pertinent information on each of the major and minor aquifers is presented in Table III-4. A more detailed and comprehensive discussion on the geologic character and hydraulic characteristics of the aquifer quality, and quantity of water present versus availability, etc., is presented in Appendix C of the Basin Appendixes. Some idea as to the geologic reference of the various aquifers is shown in Plate II-1.

Development.

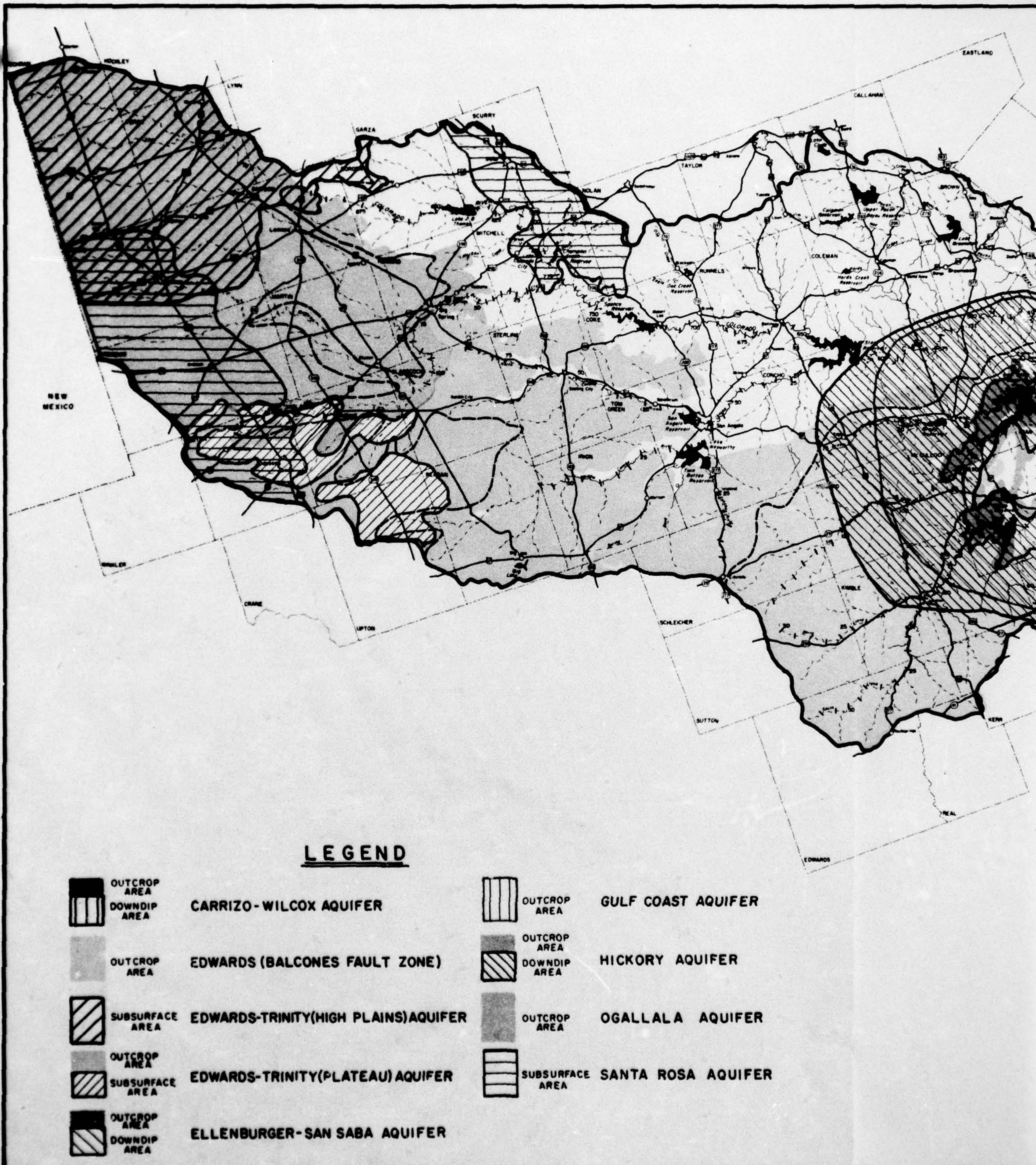
Primary developments of ground water have been from the Ogallala Formation and Santa Rosa Sandstone in the upper Basin; the Edwards-Trinity (Plateau), Ellenburger-San Saba, and Hickory Aquifers in the middle Basin; and the Carrizo-Wilcox and Gulf Coast Aquifers in the lower Basin. Major cities obtaining ground water from the Ogallala Formation in the upper Basin are Andrews, Brownfield, Lamesa, Midland, and Seminole. Snyder pumps ground water from the Santa Rosa Sandstone for some of its municipal supply. Numerous smaller communities also depend on ground water from these aquifers for their water requirements.

TABLE III - 4

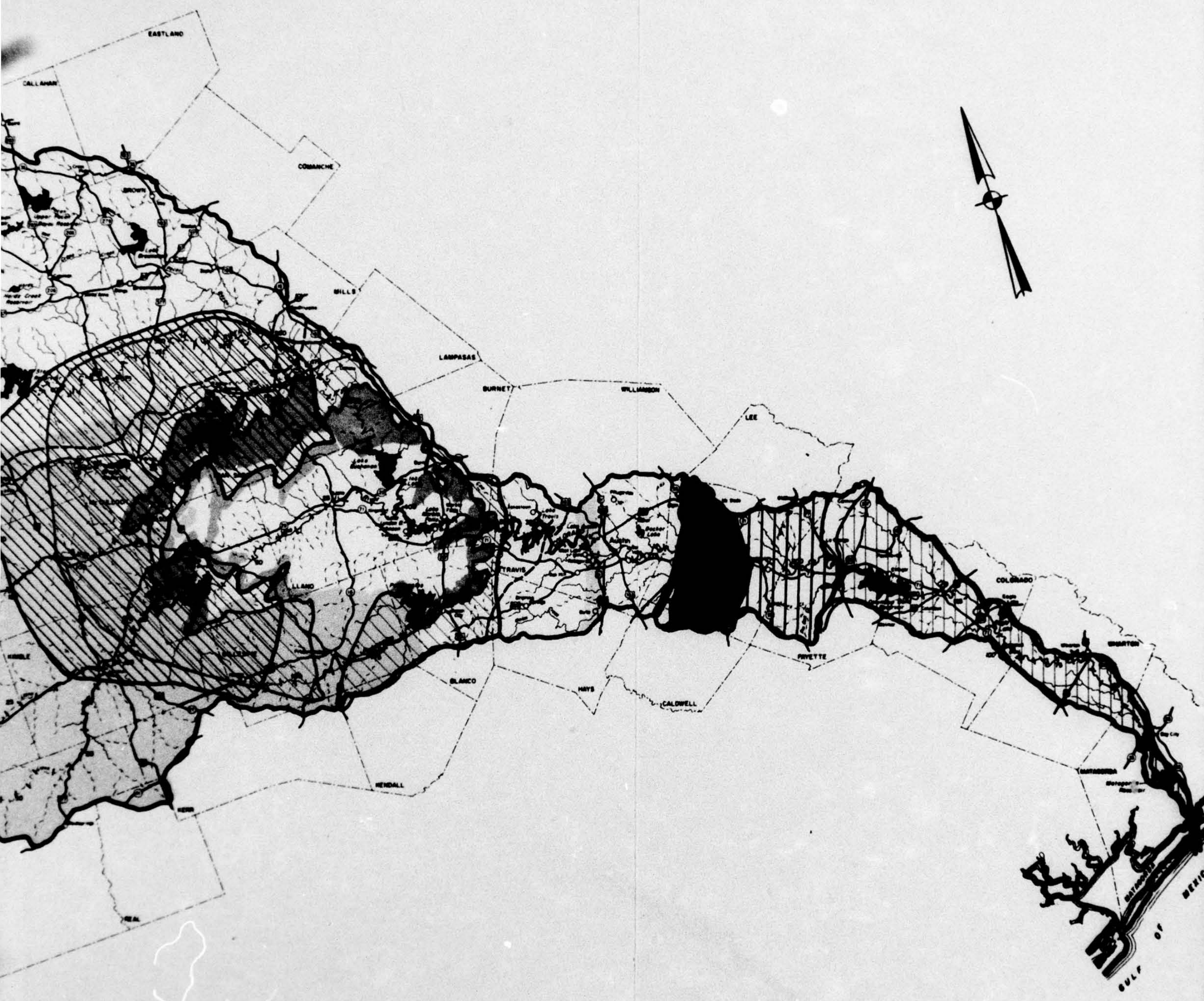
AVAILABILITY OF GROUND WATER IN THE COLORADO RIVER BASIN

Aquifer	General Lithology and Range in Thickness	Range in Well Yields (Gallons per minute)	Range in Well Specific Capacity (Gpm per foot of drawdown)	Range in Transmissibility (Gallons per day per foot)	Estimated Perennial Yield (1,000 acre-feet)	Estimated Amount of Water Recoverable from Storage (1,000 acre-feet)
Ogallala	Sand and gravel, 100-300 feet thick	100-500	5-50	6,000-38,000	200	18,500
Edwards-Trinity (High Plains)	Sand and vugular limestone, 50-150 feet thick	50-150	10-100	_[1]	22	3,300
Santa Rosa	Sand and gravel, 100-400 feet thick	100-1,000	5-50	1,500-6,000	40	1,500
Edwards-Trinity (Plateau)	Sand and cavernous limestone, 600-1,200 feet thick	50-1,000	5-75	_[1]	175	19,000
Hickory	Sandstone, 300-500 feet thick	200-500	2-13	18,000-40,000	50	1,000
Ellenburger-San Saba	Cavernous limestone 1,000-2,000 feet thick	200-1,000	10-50	_[1]	20	2,000
Edwards (Balcones Fault Zone)	Cavernous limestone 200-400 feet thick	20-500	10-200	_[1]	38	450
Carrizo-Wilcox	Sand, 100-2,500 feet thick	100-500	10-20	25,000-80,000	80	2,500
Gulf Coast	Sand, 100-1,000 feet thick	500-1,500	25-140	50,000-300,000	33	6,000
Other	Sand, limestone, gypsum, basalt, breccias, of varying thicknesses.	Various	Various	Various	28	3,000
TOTAL					666	57,250

[1] *Not applicable. All or partly turbulent flow in subterranean channels.*



HOCKLEY
LYNN
GARZA
SCURRY
NOLAN
MITCHELL
TAYLOR
CALLAHAN
EASTLAND
BROWN
COLEMAN
RUNNELS
COKE
STERLING
TOM GREEN
CONCHO
NEW MEXICO
WINKLER
CRANE
UPTON
SCHLEICHER
KIMBLE
SUTTON
KERR
REAL
EDWARDS
LEGEND
OUTCROP AREA
DOWNDIP AREA
CARRIZO-WILCOX AQUIFER
OUTCROP AREA
EDWARDS (BALCONES FAULT ZONE)
SUBSURFACE AREA
EDWARDS-TRINITY(HIGH PLAINS)AQUIFER
OUTCROP AREA
SUBSURFACE AREA
EDWARDS-TRINITY(PLATEAU) AQUIFER
OUTCROP AREA
DOWNDIP AREA
ELLENBURGER-SAN SABA AQUIFER
OUTCROP AREA
GULF COAST AQUIFER
OUTCROP AREA
DOWNDIP AREA
HICKORY AQUIFER
OUTCROP AREA
OGALLALA AQUIFER
SUBSURFACE AREA
SANTA ROSA AQUIFER



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

MAJOR AND MINOR FRESHWATER AQUIFERS

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 32 MILES	PLATE III-3

2

Brady, a major city in the middle part of the Basin, obtains part of its water supply from the Hickory Aquifer. A number of smaller communities are using ground water from the Hickory and Ellenburger-San Saba Aquifers. In the lower Basin, Wharton obtains ground water from the Gulf Coast Aquifer, and a number of smaller communities depend on ground water from the Carrizo-Wilcox Aquifer for their water requirements.

The major industrial use of ground water in the upper Basin is from the Ogallala Formation and in the lower Basin the Gulf Coast Aquifer. In the middle Basin very little ground water is utilized for industrial purposes. Ground water is being used for water-flood operations primarily in the upper Basin.

Large quantities of ground water are obtained from the Ogallala Formation for irrigation purposes on the High Plains in the upper Basin. Also, ground water from the Santa Rosa Formation is utilized for irrigation in part of the upper Basin. In the middle Basin, irrigation water is obtained from the Hickory and Edwards-Trinity (Plateau) Aquifers and in the lower Basin, from the Gulf Coast Aquifer.

One can more keenly realize the major utilization and dependence of the Basin on ground water by reviewing use statistics. In 1960, 32,900 acre-feet and 27,600 acre-feet were used respectively for municipal and industrial purposes. These values increased proportionately in 1970. While the municipal and industrial needs provided are relatively small, the dependence on ground water for irrigation in the Basin is phenomenal. In 1969, 550,992 acre-feet of ground water--83 percent of the total water used for irrigation in the Basin--was used to irrigate 838,056 acres. A sizable portion of the ground water used annually is pumped from the Ogallala Aquifer.

Water Uses and Requirements.

Water uses and requirements utilized in this study were taken from those Basin requirements outlined in the Texas Water Plan (hereafter referred to as "the Plan") or subsequent revisions as developed by the Texas Water Development Board (TWDB). The various municipal, industrial, irrigation, mining, etc. requirements are essentially an updating of the data presented in the plan. The basic assumptions and logic employed in the initial development of the projections in the Plan have not changed and can be found therein.

Municipal and Industrial

Future municipal and industrial requirements developed with benefit of the 1970 Census data, are notably lower than those projected in the Plan. The Basin did not experience, and for that matter neither did the State, the extensive growth predicted in the Plan. However, as seen in Table III-5, and graphically illustrated in Figure III-2, there is a sustained increase in both the municipal and industrial projected requirements. Detailed water-use and requirement information is included in the Basin Appendix.

Table III-5

Historical and Projected Municipal, Industrial, and Irrigation Water Uses (Acre-ft/yr)

	1970	1980	1990	2020
Municipal	142,735	173,029	208,165	361,038
Industrial	37,723	52,867	61,573	102,963
Irrigation	661,330	583,022	514,900	361,000

The total municipal and industrial water use of 180,458 acre-feet in 1970 represented an increase of approximately 25 percent over the 143,900 acre-feet used within the Basin in 1960. Of the 160,883 acre-feet used for municipal purposes, approximately 72.5 percent was used in the urban areas of the Basin where 73.2 percent of the total 1970 Basin population is located. The usage in the rural areas amounted to a mere 44,162 acre-feet, which constitutes an average use of 39.4 mgd. The specific requirements of the urban areas are detailed in Table III-6.

Daily per capita water usage (which was calculated by dividing the total municipal water use by the Basin population) in the Basin averaged about 151 gallons in 1970. This per capita usage is projected to increase to 162 gallons in 1990, and increase yet another 27 gallons by 2020. The specific per capita usage varies throughout the Basin, and an analysis of water-use data did not reflect any significant consistent trends. It was noted that the per capita usage in the metropolitan areas during 1970 varied from 135 gallons in Tom Green County to 170 gallons in Midland County. Travis County, the most populous county in the Basin--295,431 people--experienced a per capita usage rate of 163 gallons in 1970.

FIGURE III-2

HISTORICAL AND PROJECTED MUNICIPAL, INDUSTRIAL AND IRRIGATION WATER USES IN THE COLORADO RIVER BASIN

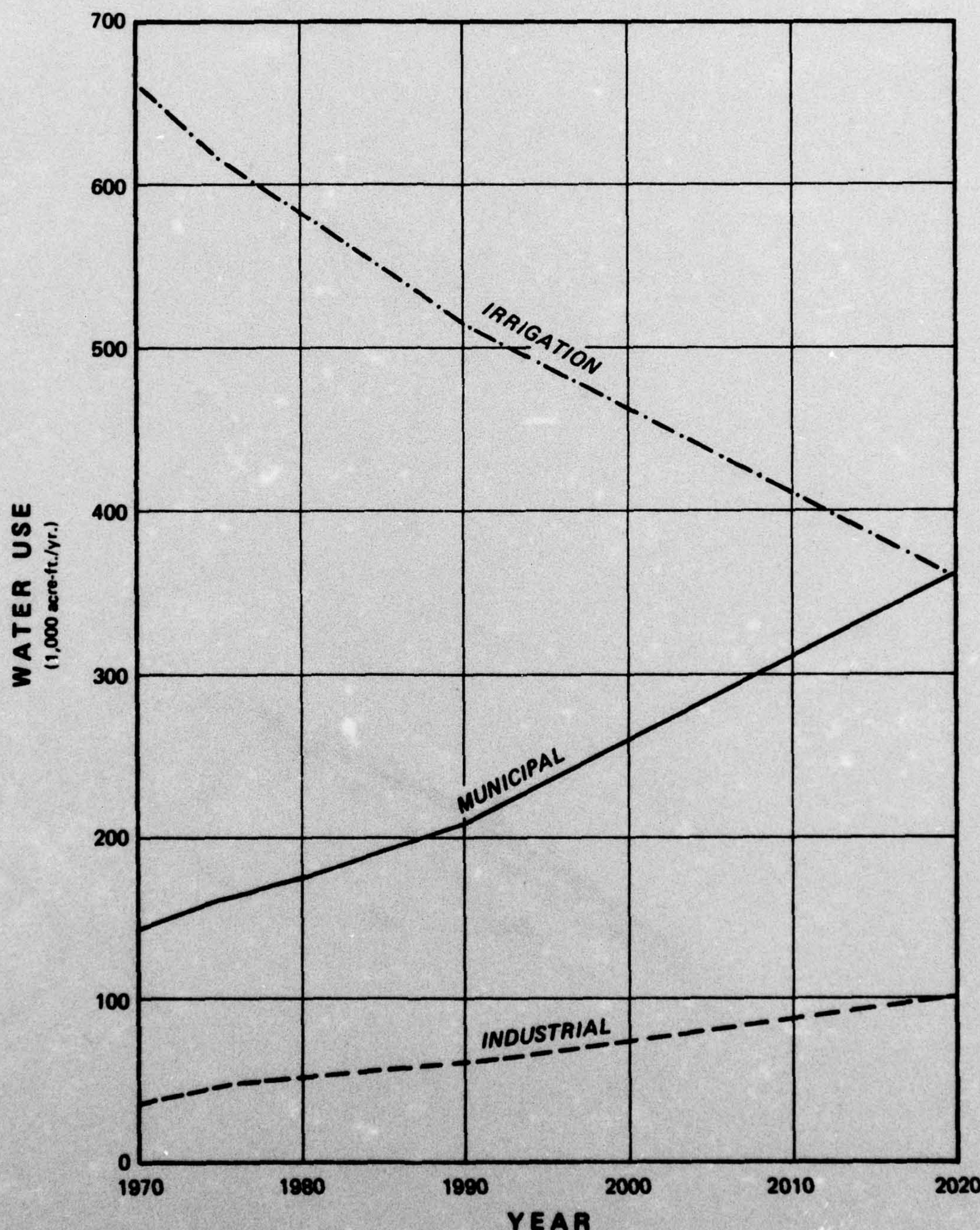


TABLE III-6

HISTORIC AND PROJECTED ANNUAL ZONE MUNICIPAL, INDUSTRIAL, AND IRRIGATION WATER REQUIREMENTS[1] IN THE COLORADO RIVER BASIN
(Units – acre-feet)

MUNICIPAL AND INDUSTRIAL

ZONE AND CITY	1970 M	1970 I	1980 M	1980 I	1990 M	1990 I	2020 M	2020 I
ZONE 1								
ANDREWS	2,208	261	2,386	265	2,514	290	2,747	344
BIG SPRING	5,387	2,308	6,569	2,927	7,403	3,333	9,815	4,928
BROWNFIELD	1,534	–	1,809	–	2,007	–	2,543	–
COLORADO CITY	942	31	894	34	843	36	593	47
DENVER CITY	880	64	1,033	74	1,084	79	1,120	99
LAMESA	1,508	18	1,593	22	1,587	22	1,428	24
MIDLAND	11,773	83	13,223	150	14,260	190	16,665	322
ODESSA	13,111	2,309	16,485	4,139	19,535	5,254	30,363	10,756
SEMINOLE	1,149	–	1,171	–	1,193	–	1,170	–
SNYDER	2,132	–	2,172	–	2,113	–	1,794	–
OTHERS	8,412	11,641	8,112	15,008	8,687	15,904	9,086	22,617
TOTAL	49,044	16,775	55,456	22,648	61,226	25,117	77,324	39,136
ZONE 2								
BALLINGER	738	20	775	22	759	24	662	29
BRADY	1,508	473	1,382	496	1,246	532	813	667
BROWNWOOD	4,504	753	4,739	937	4,934	1,084	5,181	1,677
COLEMAN	1,089	–	964	–	798	–	446	–
SAN ANGELO	10,108	318	12,566	421	14,953	472	23,596	664
SAN SABA	694	–	613	–	510	–	262	–
WINTERS	418	–	439	–	430	–	394	–
OTHERS	6,624	2,441	6,270	3,118	6,330	3,258	5,618	4,565
TOTAL	25,687	4,005	27,748	4,994	29,960	5,370	36,962	7,582
ZONE 3								
AUSTIN	49,937	3,048	68,593	3,850	92,589	4,350	212,164	6,267
BURNET	488	–	587	–	678	–	1,010	–
FREDERICKSBURG	1,175	–	1,530	–	1,765	–	2,490	–
JUNCTION	718	588	784	666	817	709	847	860
LLANO	723	–	868	–	1,014	–	1,459	–
OTHERS	7,481	1,305	9,108	1,003	11,042	938	18,141	2,719
TOTAL	60,522	4,961	81,470	5,519	107,905	5,997	236,111	9,846
ZONE 4								
BASTROP	578	7	689	13	804	14	1,170	20
COLUMBUS	594	1	673	1	734	1	829	2
EAGLE LAKE	451	–	546	–	604	–	717	–
ELGIN	650	–	890	–	1,062	–	1,787	–
EL CAMPO	207	–	245	–	254	–	272	–
GIDDINGS	563	–	678	–	737	–	801	–
LA GRANGE	483	–	520	–	737	–	491	–
SMITHVILLE	369	–	475	–	519	–	859	–
WHARTON	100	5	119	5	580	–	153	7
OTHERS	3,497	11,979	3,510	19,688	3,670	25,078	3,882	48,399
TOTAL	7,492	11,992	8,365	19,707	9,074	25,099	10,841	48,399
TOTAL	142,735	37,723	173,029	52,867	208,165	61,573	361,838	102,963

IRRIGATION

ZONE	1964 GW	1964 SW	1964 Total	1969 GW	1969 SW	1969 Total	1980 GW	1980 SW	1980 Total	1990 GW	1990 SW	1990 Total	2020 GW	2020 SW	2020 Total
ZONE 1	831,000	1,000	832,000	426,800	1,943	428,743	337,903	918	338,821	259,000	-0-[2]	259,000[2]	78,300	-0-[2]	78,300[2]
ZONE 2	72,100	41,100	113,200	77,970	55,591	133,561	76,028	57,216	133,244	74,700	58,900[2]	133,600[2]	72,000	58,900[2]	130,900[2]
ZONE 3	5,500	9,000	14,500	12,950	8,640	21,590	8,653	9,809	18,462	4,800	10,900	15,700	4,000	15,200	19,200
ZONE 4	17,100	38,800	55,900	33,272	44,164	77,436	32,038	60,457	92,495	31,100	76,500	108,600	17,000	115,600	132,600
TOTAL	925,700	89,900	1,015,600	550,992	110,338	661,330	454,622	128,400	583,022	369,600	145,300	514,900	171,300	189,700	361,000

[1] Base data developed by the Texas Water Development Board.

[2] Does not include annual irrigation requirements to be met from out-of-state imports, estimated to be by 2020: Zone 1 – 4,983,200 acre-feet; Zone 2 – 765,300 acre-feet.

As seen in Table III-5, municipal requirements are forecast to increase to 361,038 acre-feet/year (about 322 mgd) by 2020. This represents an annual average increase of 4,366 acre-feet/year, or about 3 percent a year, which compares to an average annual increase of about 2 percent in the Basin population over the study period. During the study period, industrial requirements are projected to increase 173 percent and total 102,963 acre-feet a year by 2020. The industrial development spawning the increased use is distributed throughout the Basin. While the development is primarily associated within the metropolitan areas, the tremendous potential of industrial growth in Matagorda County is evidenced by the fact that approximately 31 percent (31,684 acre-feet) of the total projected Basin industrial requirement in 2020 is to be expended in the County.

Through 1990, the principal source of supply for these requirements will be the ground water reserves in the Basin. Surface water development in the upper and central parts of the Basin will (should out of necessity) result in increased use of surface water in these areas. Coastal needs will probably be met entirely by ground water. By 2020, additional surface water development will be required to offset the dwindling ground water reserves in the High Plains and alleviate some of the extensive pumping in the coastal areas.

Irrigation

The 1969 Irrigation Inventory provides the latest data available on irrigation in the Basin. Unlike the municipal and industrial water use forecasts, the irrigation water requirements noted in Table III-7 are not requirements per se, but rather an estimate of the amount of water which can be provided for this purpose by in-Basin water sources by the respective years. A detailed county breakdown of the irrigation uses is presented in Appendix A of the Basin Appendix.

As seen in Table III-7, ground water is currently the primary source of water used for irrigation. Forty-three of the 62 counties in the Basin use ground water to irrigate crops. In 1964, 91 percent (925,700 acre-feet) of the 1,015,600 acre-feet used for irrigation in the Basin was supplied by ground water resources. The total amount of water used for irrigation decreased to 661,330 in 1969, yet 83 per cent of the water used was ground water. The dramatic decrease in irrigation water use in the brief five-year span, 1964-1969, is attributed to a difference in rainfall for the two inventory years (1964 and 1969), as well as the decreased use of ground water in the High Plains and those counties immediately east of the escarpment in the upper Basin. The primary ground water reservoir in this area, the Ogallala Aquifer, is in effect being mined--that is,

TABLE III - 7

HISTORIC AND PROJECTED IRRIGATION[1]

WATER REQUIREMENTS AND IRRIGATED ACREAGE

	Surface Water		Ground Water		Total	
Year	Acres	Acre-Feet	Acres	Acre-Feet	Acres	Acre-Feet
1964	44,961	89,900	678,897	925,700	724,858	1,015,600
1969	56,196	110,338	838,056	550,992	894,252	661,330
1975	58,836	120,014	705,823	497,125	764,659	617,139
1980	61,419	128,400	597,833	454,622	659,252	583,022
1990	66,700	145,300	381,800	369,600	448,500	514,900
2020	86,500	189,700	135,500	171,300	222,000	361,000

[1] *Source: Texas Water Development Board*

water is being pumped from the aquifer faster than the aquifer is being recharged. Consequently, efforts are being made to conserve the precious remaining reserves in the Ogallala; thus, the reduction in irrigation water usage.

Some idea as to the magnitude of this problem is seen in the irrigation water-use data for the area. For example, in 1969, 426,800 acre-feet of ground water was used to irrigate crops in the Zone 1. This amount represented approximately 77.4 percent of the ground water used in the Basin, and 64.5 percent of the total water used for irrigation in the Basin during 1969.

By 1990, unless some relief is provided to rejuvenate the fluctuating situation in the upper Basin, only 514,900 acre-feet of water will be used for irrigation in the Basin. Of this total, 72 percent is projected to be supplied by ground water, and the total irrigated acreage is forecast to decline to 448,500 acres--slightly more than half of the acres irrigated in 1969. Coastal irrigation is expected to increase, based on a probable increase in the demand for rice, improved pastures, and the large number of field crops that are well suited to irrigated production on the Colorado River delta soils.

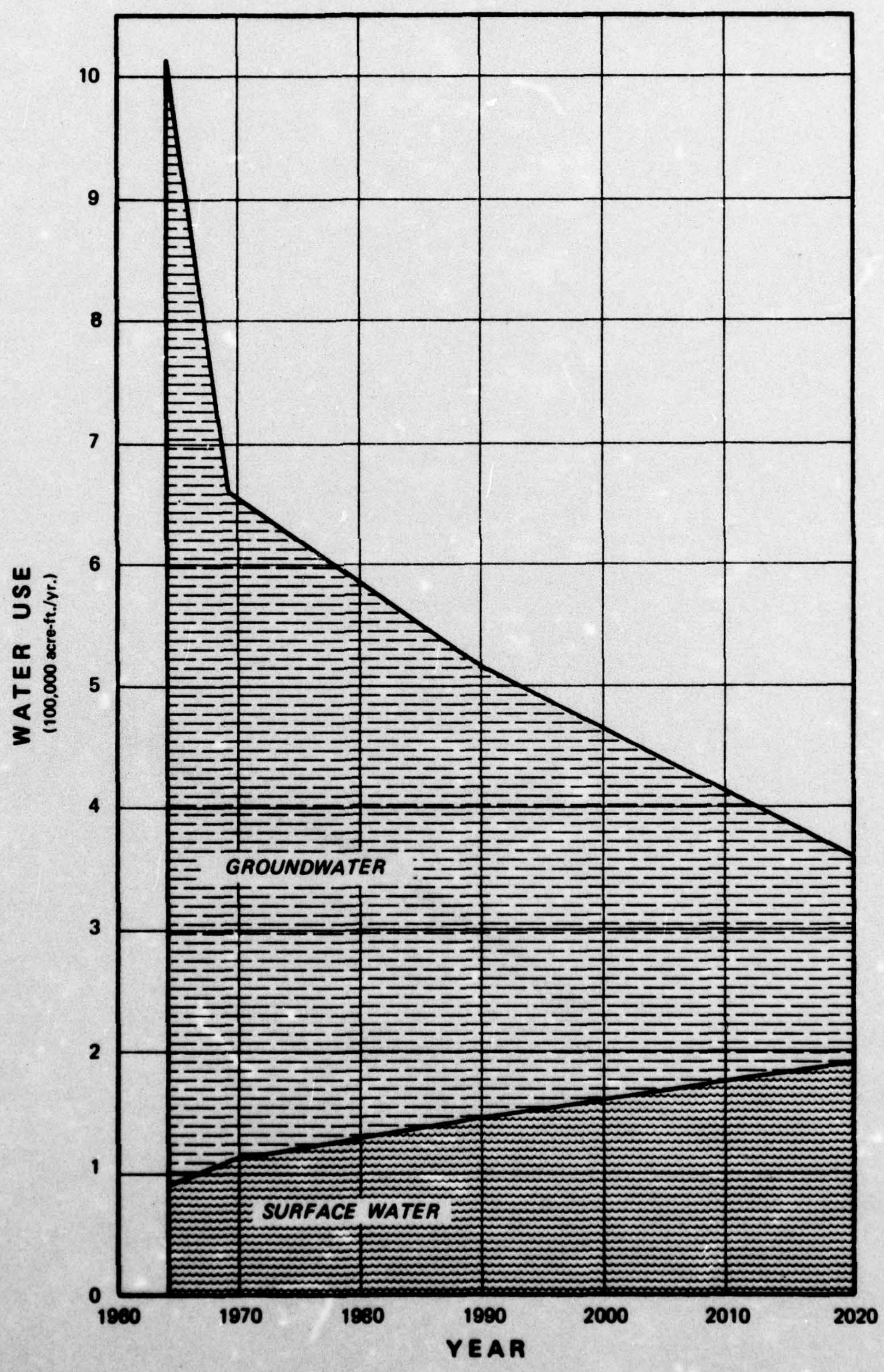
With the continued depletion of the Ogallala, surface water is projected to be the major supply of irrigation water in 2020 (Figure III-3). The total irrigated land area is expected to decrease in half again between 1990 and 2020. Further, the Basin will have experienced an appalling 45 percent decrease in the amount of water available for irrigation use.

Mining (Water Flooding-Secondary Recovery).

Extensive petroleum production in the Colorado River Basin has resulted in significant usage of water for water flooding. The use amounted to 98,500 acre-feet in 1960, which was exclusively ground water. Since 1960, there has been an increased use of surface water for this purpose. The surface water is usually high in chloride content, which prevents its use for municipal, industrial, or irrigation needs. In 1972, the Colorado River Municipal Water District sold 3014.3 acre-feet of surface water to various oil companies in the upper Basin for this purpose. The water was diverted from the Colorado River at the low-flow diversion works above E. V. Spence Reservoir to an off-channel storage facility. It was, in turn, pumped to the oil companies upon request.

FIGURE III-3

HISTORICAL AND PROJECTED IRRIGATION WATER USE



The TWDB has projected that the annual use of 98,500 acre-feet will continue through 1990. By 2020, however, they note that the need for water flooding is expected to reduce, resulting in an estimated annual requirement of only 14,900 acre-feet.

Hydroelectric Power Generation.

There are currently six hydroelectric power generation installations in the Basin. They are located one on each of the Highland Lakes, and the six installations have the following capacities:

Buchanan	33,750 kilowatts
Inks	12,500 kilowatts
Lyndon B. Johnson	45,000 kilowatts
Marble Falls	30,000 kilowatts
Travis	67,500 kilowatts
Austin	13,500 kilowatts

The entire system of installations is owned and operated by the Lower Colorado River Authority.

The frequency and duration of power generation is dependent on numerous variables, primary of which are the required releases to fulfill water requirements downstream and the periodic releases to offset excess flood water. The entire system of water releases--hydroelectric power generation, reservoir content control, etc. -- is managed by use of a computer model simulation of the Highland Lakes System. It should be noted that in the development of the Plan, the storage required for power generation (both power pool and power load) in the above six reservoirs was excluded in computing the water supply available for other uses. This was necessitated due to the difficulty in analyzing power benefits and because, historically, power pools are not maintained during period of severe drought.

The possibility of the installation of hydroelectric power generation at several of the proposed reservoirs was evaluated by the TWDB during the development of the Plan but was not found to be economically feasible.

Flood Control.

The Colorado River Basin has been subjected to some of the most severe flooding experienced anywhere in Texas. The frequency of floods throughout the entire Basin has been fairly uniform, with major floods occurring on the average of once every 4-1/2 years and minor flooding about once a year.

In an effort to control the costly damages resulting from flooding, flood-control storage, totaling 1,509,600 acre-feet, is provided in three of the existing reservoirs. The proposed reservoirs, on the main stem of the Colorado River, Stacy, and Columbus Bend, are scheduled to provide for 659,300 and 481,700 acre-feet, respectively, of flood-control storage. Upper Pecan Bayou as proposed will contain an additional 102,700 acre-feet of storage. Flood control, by either structural or nonstructural methods, is also needed on the San Saba, Llano, and Pedernales Rivers.

As part of an extensive watershed program for the Basin, numerous small floodwater-retarding structures have been planned for construction or authorized by Congress. Also, several miles of planned channel improvement within the Basin have been completed,

Navigation.

Currently, the Colorado River is navigable for barge traffic for the initial 22.8 miles. The feasibility of navigation in the Colorado River as far upstream as Austin has been studied and investigated, and some information has been developed on possible lockage requirements associated with this development. To date, these investigations have not indicated that navigation is economical or likely to be realized in the foreseeable future. However, in the Plan, provisions were made for meeting the net navigation water requirements for the lowermost lockage, 40,700 acre-feet per year, should this development ever become feasible.

Recreation and Fish and Wildlife.

Recreation, fish, and wildlife needs were provided for in the Plan, where applicable. However, specific water requirements for these uses were not assigned, as they are generally nonconsumptive in nature. Numerous fish hatcheries and other game havens are situated throughout the Basin. Although not always designed so, recreation activity is usually inherent with most large reservoirs, and there is an

abundance of these reservoirs in the Basin. For further details see Section II.

In the development of the Plan, the primary objective is to protect and enhance the quality of existing as well as proposed water resources so that they can fulfill their designated uses. In designating the uses for the streams in the Basin, the State attempted to recognize present as well as practicable future uses and, where possible, provide for a variety of uses. As seen in Plate IV-1, the water uses designated for the streams in the Basin include recreation as well as fish and wildlife propagation. The recommendations of the Plan are dedicated to that end.

Various State and local agencies are scrutinizing the water quality of reservoirs and flowing streams within the Basin with an eye to the capability of these waters to supporting their designated uses. Extensive investigations are currently in progress to establish the relationship of freshwater inflows into coastal waters and the attendant effects on the flora and fauna of the coastal areas. The results of these investigations are very important in view of the current boom of coastal recreational activity and the value of commercial fisheries.

Planned Water Resource Development.

The course of water resource development through the year 2020 was notably plotted in the Texas Water Plan of 1968. The development as outlined in the Plan provided for the maximum economically-feasible utilization of recoverable ground water resources. Existing and proposed surface water developments were to supplement ground water resources in meeting the projected water requirements. Development of water resources within the Basin was to complement the overall State plan of water resources development. A solution was sought to the problem of the dwindling ground water reserves in the High and Rolling Plains portion of the Basin; however, use of in-State resources to alleviate this problem proved not economically feasible. The State did not grow as projected in the Plan, and consequently it is entirely probable that many of the Plan's projected needs and ultimate construction dates will slide in time. The proposed development within the Basin, as outlined in the Plan, is presented in the attendant discussion. It should be noted that the values presented for the surface water development component of the scheme are ultimate and should be reviewed in that light.

As noted earlier, the projected water requirements were divided into the aforementioned four zones. In meeting these zone requirements, the fullest practicable use was made of ground water resources. In 1960, ground water supplied approximately 42 percent of the municipal and industrial uses. The Plan projected that by 1990 it will supply only 28 percent. In 2020, a mere 22 percent of the projected municipal and industrial needs will be met by ground water resources. Further, as seen in Table III-7, where ground water supplies 92 percent of the irrigation water in the Basin during 1964, it will provide only 53 percent of the projected 2020 use. The major reason for these sharp declines in use is the declining availability of ground water in the High Plains and Rolling Plains portion of the Basin.

The TWDB, as well as local agencies, has launched extensive efforts to determine some method of importing water or increasing water availability in the area. To date several studies have been conducted to determine the economic feasibility of supplying a portion of the future projected needs of the area--5.7 million acre-feet/year by 2020 solely for irrigation purposes. Thus far, all studies have shown this proposal too costly. The U.S. Corps of Engineers and U.S. Bureau of Reclamation recently released the results of their study on the feasibility of importing water from the Mississippi River to the water-poor areas of West Texas and eastern New Mexico. It was the general conclusion of the study that the above importation scheme was not economically feasible. Further, it was the recommendation of the study that efforts be initiated to revert to dryland farming techniques and crop selection compatible with the rainfall of the respective areas. In light of the findings of the study, the situation in West Texas looks even more critical.

While the problem of ground water availability in Zones 1 and 2 is projected to become even more acute, ground water use in Zone 3 has historically been small and is expected to remain so. The coastal sands (in Zone 4) provide and should continue to provide most of the water for municipal and industrial needs through 2020, while contributing 1/3 of the water used for irrigation in the region through 1990.

After allocating the available ground water, a surface water development plan was prepared to supplement the remaining needs. The usable surface water yield was determined. The location, kinds, and amounts of storage contemplated, and the respective demands on this storage were evaluated in this determination. The runoff data used in this study were from the most critical period of record, adjusted to projected development within the Basin by 2020. The evaluation of numerous alternatives produced the scheme delineated in Table III-8. The reservoir development portion of the scheme is outlined in Figure III-4.

TABLE III - 8

SURFACE-WATER SUPPLY PROJECTS NECESSARY TO MEET BASIN REQUIREMENTS IN 2020, COLORADO RIVER BASIN, TEXAS[1]

Reservoir	Status	Annual Requirement Supplied (acre-feet)		Usable Return Flows (acre-feet)	Remaining Yield (acre-feet)
		Projects in Zone 1			
Canadian River basin import		Brownfield	2,300	–	–
		Lamesa	2,200	–	–
			4,500	None	None
J. B. Thomas	Existing	Big Spring	30,600	–	–
Robert Lee	Existing	Snyder	6,500	–	–
		Odessa	28,800	–	–
		Midland	15,600	–	–
			81,500	15,600	None
Colorado City plus Champion Creek	Existing	Colorado City	6,100	None	2,100
Oak Creek	Existing	Other cities	1,000	None	None
		Sweetwater	2,400		
			3,400	None	None
Stacy	Proposed	Odessa	40,600	–	–
		Midland	8,800	–	–
			49,400	See Zone 2	–
				Zone 1 subtotal ·······	2,100
		Projects in Zone 2			
Twin Buttes	Existing	San Angelo	18,700	–	–
San Angelo	Existing	Irrigation (P)	20,000	6,000	–
			38,700	6,000	6,000
Hords Creek	Existing	Coleman	1,000	–	–
Jim Ned Creek	Existing	Coleman	3,700	None	3,500
Brady	Existing	Brady	5,800	None	3,000
Brownwood	Existing	Brownwood	12,900	–	–
		Irrigation (P)	11,200	3,400	–
			24,100	5,600	9,000
Pecan Bayou	Proposed	–	–	–	4,300
Stacy	Proposed	Ballinger	2,300	–	–
		San Angelo	23,300	–	–
		Odessa	40,600	–	–
		Midland	8,800	–	–
		Irrigation (NP)	17,800	–	–
			92,800	17,800	32,000
Zone Boundary Irrigation (NP)			9,900	15,100	5,200
				Zone 2 subtotal ·······	53,600

[1] *Source: "A Summary of the Preliminary Plan for Proposed Water Resources Development in the Colorado River Basin, Texas Water Development Board, July 1966. (Requirements do not include surface water irrigation requirements for High Plains and Rolling Plains areas.)*

TABLE III - 8 (Cont'd.)

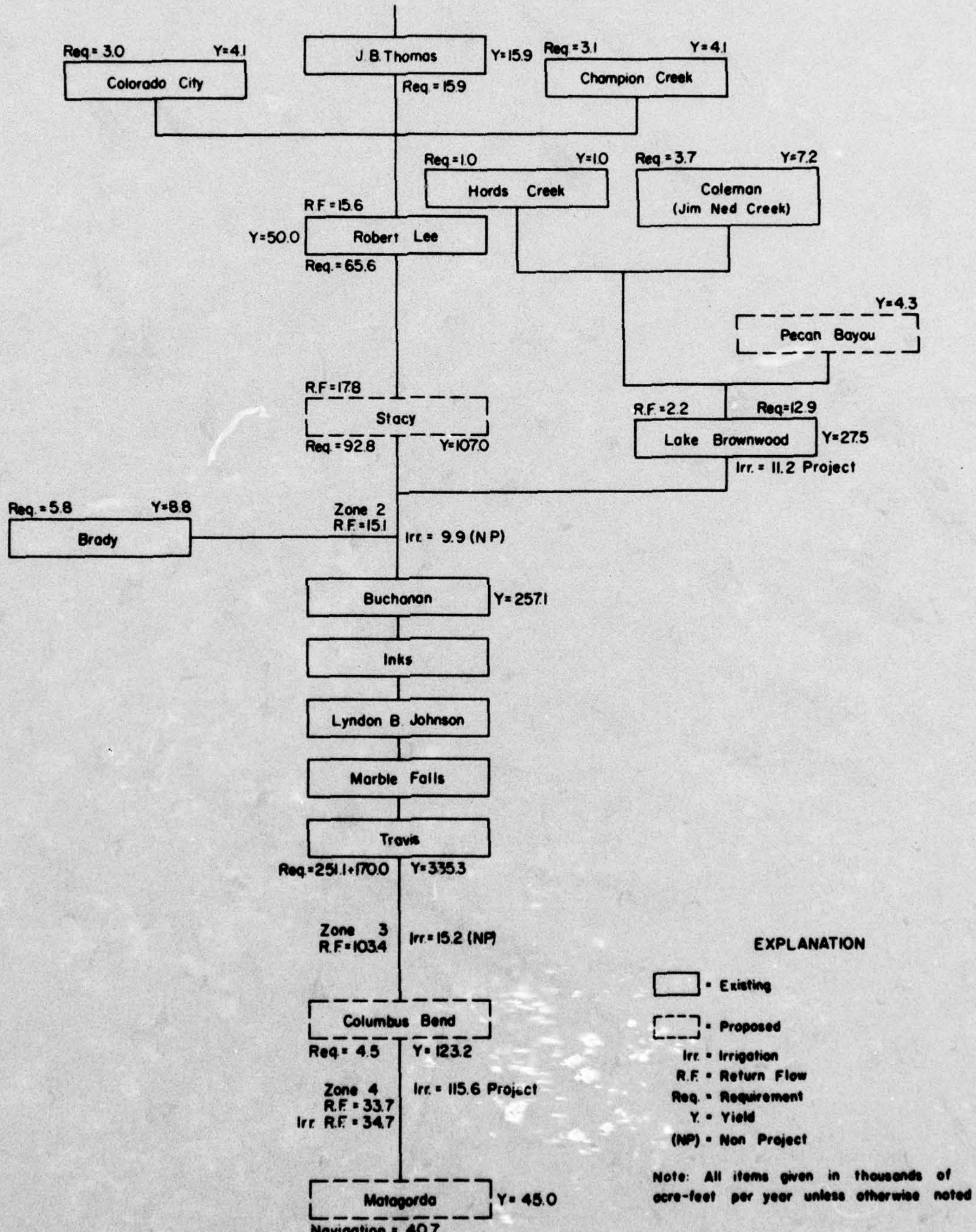
Reservoir	Status	Annual Requirement Supplied (acre-feet)		Usable Return Flows (acre-feet)	Remaining Yield (acre-feet)
		Projects in Zone 3			
Buchanan	Existing	Austin	244,100	–	–
Travis	Existing	Other cities	7,000	–	–
		San Antonio	170,000	–	–
			421,100	–	171,300
Zone Boundary Irrigation (NP)			15,200	103,400	88,200
				Zone 3 subtotal -------	259,500
		Projects in Zone 4			
Columbus Bend	Proposed	Other cities	4,500	–	–
		Irrigation (P)	115,600	–	–
			120,100	–	3,100
Matagorda	Proposed	Irrigation	–	34,700	–
		Municiapl and Industrial	–	33,700	–
			–	68,400	113,400
				Zone 4 subtotal ------	116,500

BASIN BALANCE
(acre-feet)

Zone remaining yields (from above)		
Zone 1	2,100	
Zone 2	53,600	
Zone 3	259,500	
Zone 4	116,500	
	431,700	431,700
Import to Lower Basin by Interbasin Canal		
Replacement Stacy	70,000	
Replacement of irrigation export to Lavaca River basin	87,800	
San Antonio replacement	170,000	
	327,800	327,800
Zone Surpluses and Imports		759,500
Exports		
To Brazos-Colorado Coastal basin	236,200	
To Colorado-Lavaca Coastal basin	181,700	
To Lavaca River basin	190,100	
(Existing irrigation .... 87,800)		
(Proposed new irrigation .... 102,300)		
Total exports	608,000	608,000
Basin surplus		151,500 [2]

[2] *Basin optimization will allow storing upstream and/or supplying navigation requirements at lowermost lockage.*

Figure III-4
PROPOSED RESERVOIR DEVELOPMENT COLORADO RIVER BASIN



SOURCE: Adopted from, "A Summary of the Preliminary Plan for Proposed Water Resources Development in the Colorado River Basin," Texas Water Development Board, July 1968.

Basically, the scheme consists of utilizing the existing reservoirs, rehabilitating the Brownwood Dam, constructing four major reservoirs, and importation to and exportation from the Basin. According to the Plan, the ultimate development of the system should result in sufficient surface water reserves to supply about 78 percent of the anticipated municipal and industrial needs within the Basin in 2020. Also by 2020, the amount of surface water expected to be used for irrigation (189,700 acre-feet) will constitute 52 percent of the projected 2020 irrigation water use.

As seen in Table III-8, the Canadian River Aqueduct (from Lake Meredith, Canadian River Basin, in the Texas Panhandle) is planned to continue to provide water to the cities of Brownfield and Lamesa through 2020. Oak Creek Reservoir is supposed to continue to provide the City of Sweetwater (Brazos River Basin) with water at an annual rate of 2,400 acre-feet through 2020.

One specific point bears noting at this time. The proposed plan of surface water development reflected that an appreciable part of the proposed surface development results from recoverable and usable return flows to Basin streams. In view of the recent enactment of PL 92-500 and its provisions regarding high levels of treatment of wastewater prior to discharge into the stream, there could conceivably be a notable reduction in the amount of return flows to the stream.

IV. WATER QUALITY

Introduction.

This section presents a review of pertinent water quality information for the Colorado River Basin. This information includes a review and summary of stream standards, existing water quality data evaluation, and areas of water quality degradation.

The discussion under each topic relies upon the geographic identification as related to hydrological subregions defined on the accompanying map (Plate IV-5), as well as locations in regard to stream monitoring stations and tributaries. Briefly delineating these hydrologic subregions: Region I is the Basin area beginning at Tidal and terminating on the main stream at Mansfield Dam, Austin; Region II is the Basin area encompassed from Longhorn Dam to a point slightly upstream of the Colorado River confluence with the San Saba River and includes the Highland Lakes chain, Pedernales, Llano, and San Saba Rivers; Region III is the Basin area encompassed from the point upstream of the Colorado and San Saba Rivers' confluence to the headwaters of the Colorado River, including Pecan Bayou, Concho River, Beals Creek, and Johnson, Midland, and Mustang Draws; Region IV is the noncontributing area of the Basin west of the Colorado River headwaters.

The presentations of these topics follow a format as defined by the hydrologic subregions. The main stream Colorado River discussion is presented from Region I to Region III, and then the major tributaries are discussed by the hydrologic subregions they lie within.

Water Quality Standards.

Water quality standards in the State of Texas have been established by the Texas Water Quality Board under the authority of the Texas Water Quality Act. The waters of the State have been classified as inland and tidal waters by the 1967 Texas Water Quality Requirements. The 1967 Requirements further divided the waters of the State into river and coastal basins, each with a numerical code. Water quality criteria for various parameters were then established for reaches of the main stream and major tributaries within each Basin.

The passage of the PL 92-500 precipitated a review of the State's stream standards. At the time of the preparation of this report, a copy of the "Proposed Stream Standards" had been released for public review and comment.

The 1967 Water Quality Requirements have been condensed and presented on Plate IV-1. The "Proposed Water Quality Standards, April 1973" hereinafter referred to as 1973 proposed standards, have been summarized and presented on Plates IV-2, 3 and 4. The General Statement which accompanies the 1973 proposed standards has been included as Appendix K of the Basin Plan Appendixes, Volume 2.

There are numerous changes to the 1967 standards by the 1973 proposed standards. One change is the incorporation of stream and tidal standards into a single publication with numerical standards established for reaches and areas. Also the 5-day Biochemical Oxygen Demand (BOD_5) stream standard has not been included in the 1973 proposed standards.

The 1967 stream standards for water temperature were presented as a general statement for all inland waters. The 1973 proposed standards reflect maximum allowable water temperature for each segment of the river. These temperature standards are for mean monthly temperature. The numerical values assigned each section or reach of the river reflect the situation in the reach. The shallow flowing streams of Region III will exhibit a greater seasonal temperature change than the waters of the Highland Lakes, as reflected in the 1973 proposed stream standards.

The elimination of the BOD_5 stream standard places emphasis on the dissolved oxygen standard as the measure of biological quality in the stream. The 1973 proposed stream standard reflects a uniform minimum DO value of 5.0 mg/l, with the exception of the main stream between E. V. Spence Reservoir and the confluence with the San Saba River. This area has a minimum DO standard of 5.5 mg/l. The 1973 proposed stream standard for dissolved oxygen acknowledges that diurnal variations below the numerical value specified for short periods of time shall be allowed.

Utilizing the DO level of a stream as the measure of the biological activity can be dangerous unless thorough DO evaluation is practiced. Algae and/or aquatic weeds will by photosynthesis utilize carbon dioxide and release oxygen to the stream which may mask the presence of oxygen-demanding organics during the day-light hours that field monitoring occurs. These oxygen-demanding organics may create a severe oxygen deficiency during the dark periods of the diurnal cycle. The important distinction that determines the acceptability of a DO stream standard as the only measure of biological activity is that the stream quality monitoring program not be limited to the parameters listed in the table of stream standards.

WATER QUALITY STANDARDS

COLORADO RIVER BASIN

STREAM		CHLORIDE - (mg/l) avg. not to exceed	SULPHATE - (mg/l) avg. not to exceed	TOTAL DISSOLVED SOLIDS - (mg/l) avg. not to exceed	B.O.D. - (mg/l) avg. not to exceed	DISSOLVED OXYGEN - (mg/l) not less than	pH RANGE	COLI-SUPR.		TEMP			TOXICITY & TOXIC MATERIALS	FREE OF FLOATING OIL	FOAMING OR FROTHING MATERIAL	OTHER	RADIOACTIVE MATERIALS - in accordance with Texas Radiation Control Act
										°F MAX. UPPER LIMIT	5°F RISE ABOVE NATURAL CONDITIONS						
1401	COLORADO R. (TIDAL TO SAN SABA)	100	75	500	3.0	5.0	6.5 - 8.5	X		96	X		X	X	X	X	X
1402	COLORADO R. (SAN SABA TO BALLINGER)	150	150	1,000	4.0	5.5	6.5 - 8.5	X		96	X		X	X	X	X	X
1403	COLORADO R. (BALLINGER TO J. B. THOMAS DAM)	1,000	1,000	3,000	3.0	4.0	6.5 - 8.5	X		96	X		X	X	X	X	X
1404	ROBERT LEE RESERVOIR	250	250	1,000	4.0	5.0	6.5 - 8.5	X		96	X		X	X	X	X	X
1405	COLORADO R. (LAKE J. B. THOMAS & TO HEAD OF RIVER)	50	60	500	4.0	5.0	6.5 - 8.5	X		96	X		X	X	X	X	X
1407	PEDERNALES R.	60	40	400	3.0	5.0	6.5 - 8.5	X		96	X		X	X	X	X	X
1408	LLANO RIVER	50	30	300	3.0	5.0	6.5 - 8.5	X		96	X		X	X	X	X	X
1409	SAN SABA RIVER	60	50	500	3.0	4.0	6.5 - 8.5	X		96	X		X	X	X	X	X
1410	CONCHO RIVER	300	200	1,000	3.0	5.0	6.5 - 8.5	X		96	X		X	X	X	X	X
1411	SOUTH CONCHO RIVER	150	50	600	3.0	5.0	6.5 - 8.5	X		96	X		X	X	X	X	X
1412	MIDDLE CONCHO RIVER	50	50	300	3.0	4.0	6.5 - 8.5	X		96	X		X	X	X	X	X
1413	NORTH CONCHO RIVER	100	100	500	3.0	4.0	6.5 - 8.5	X		96	X		X	X	X	X	X
1400	OTHER WATERS					SEE GENERAL STATEMENT											

WATER USES

COLORADO RIVER BASIN

STREAM		CONTACT RECREATION	DOMESTIC RAW WATER SUPPLY	INDUSTRIAL SUPPLY	NON-CONTACT RECREATION	PROPAGATION OF FISH & WILDLIFE	FISHING	AESTHETICS	MINING & RECOVERY OF MINERALS	HYDROELECTRIC	IRRIGATION	NAVIGATION	INDUSTRIAL COOLING WATER
1401	COLORADO R (TIDAL TO SAN SABA)	X	X	X	X	X	X	X	X	X	X	X	X
1402	COLORADO R (SAN SABA TO BALLINGER)	X	X	X	X	X	X	X	X	X	X	X	X
1403	COLORADO R (BALLINGER TO J B THOMAS DAM)	X	X	X	X	X	X	X	X	X	X		X
1404	ROBERT LEE RESERVOIR	X	X	X	X	X	X	X	X	X	X	X	X
1405	COLORADO R (LAKE J B THOMAS & TO HEAD OF RIVER)	X	X	X	X	X	X	X	X	X	X		X
1407	PEDERNALES R	X	X	X	X	X	X	X	X	X	X		X
1408	LLANO RIVER	X	X	X	X	X	X	X	X	X	X	X	X
1409	SAN SABA RIVER	X	X	X	X	X	X	X	X	X	X	X	X
1410	CONCHO RIVER	X	X	X	X	X	X	X	X	X	X	X	X
1411	SOUTH CONCHO RIVER	X	X	X	X	X	X	X	X	X	X	X	X
1412	MIDDLE CONCHO RIVER	X	X	X	X	X	X	X	X	X	X	X	X
1413	NORTH CONCHO RIVER	X	X	X	X	X	X	X	X	X	X	X	X
1400	OTHER WATERS		THOSE USES DETERMINED TO BE IN THE PUBLIC INTEREST										

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

SUMMARY
1967 TEXAS WATER
QUALITY REQUIREMENTS

TURNER, COLLIE & BRADEN, INC - HOUSTON/PORT ARTHUR

SCALE N/A | PLATE IV-1

PROPOSED WATER QUALITY STANDARDS
FRESH & TIDAL WATERS

COLORADO RIVER BASIN*

Segment Number	Segment Description	Water Uses (Quality Deemed Suitable/Known Uses): Contact Recreation	Non-Contact Recreation	Propagation of Fish & Wildlife	Domestic Raw Water Supply	Criteria: Chloride (mg/l) avg. not to exceed	Sulphate (mg/l) avg. not to exceed	Total Dissolved Solids (mg/l) avg. not to exceed	Dissolved Oxygen (mg/l) not less than	pH Range	Coliform: Fecal/(100ml) - log. avg. not more than (see Gen. Statement)	Temperature °F (see Gen. Statement)
1401	Colorado River Tidal	s/k	s/k	s/k					5.0	6.7-8.5	200	X
1402	Colorado River - above tidal to Tom Miller Dam, including Town Lake	s/	s/k	s/k	s/k	100	75	500	5.0	6.5-8.5	200	95
1403	Lake Austin	s/k	s/k	s/k	s/k	100	75	400	5.0	6.5-8.5	200	90
1404	Lake Travis	s/k	s/k	s/k	s/k	100	75	400	5.0	6.5-8.5	200	90
1405	Lake Marble Falls	s/k	s/k	s/k	s/k	100	75	400	5.0	6.5-8.5	200	94
1406	Lake Lyndon B. Johnson	s/k	s/k	s/k	s/k	100	75	400	5.0	6.5-8.5	200	94
1407	Inks Lake	s/k	s/k	s/k	s/k	100	75	400	5.0	6.5-8.5	200	90
1408	Lake Buchanan	s/k	s/k	s/k	s/k	100	75	400	5.0	6.5-8.5	200	90
1409	Colorado River - Lake Buchanan headwater to San Saba River confluence	s/k	s/k	s/k	s/k	200	200	500	5.0	6.5-8.5	200	95

* Standards to be reviewed upon completion of Corps of Engineers' Colorado River Study, if necessary

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

TEXAS WATER QUALITY BOARD
PROPOSED STREAM STANDARDS
APRIL 1973

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: N/A | PLATE IV-2

PROPOSED WATER QUALITY STANDARDS
FRESH & TIDAL WATERS

COLORADO RIVER BASIN		WATER USES QUALITY DEEMED SUITABLE/ KNOWN USES				CRITERIA					COLIFORM	
SEGMENT												
NUMBER	DESCRIPTION	CONTACT RECREATION	NON-CONTACT RECREATION	PROPAGATION OF FISH & WILDLIFE	DOMESTIC RAW WATER SUPPLY	CHLORIDE (mg/l) avg. not to exceed	SULPHATE (mg/l) avg. not to exceed	TOTAL DISSOLVED SOLIDS (mg/l) avg. not to exceed	DISSOLVED OXYGEN (mg/l) not less than	pH RANGE	FECAL/ (100ml) - log. avg. not more than (see Gen. Statement)	TEMPERATURE °F (see Gen. Statement)
1410	Colorado River - San Saba River confluence to E.V. Spence Reservoir (Robert Lee Dam)	s/k	s/k	s/k	s/k	400	300	1,250	5.5	6.5-8.5	1,000	96
1411	E.V. Spence Reservoir	s/k	s/k	s/k	s/k	500	500	1,500	5.0	6.5-8.5	200	93
1412	Colorado River - FM 2059 near Silver to Lake J.B. Thomas (Colorado River Dam)		s/k	s/k		8,000	2,500	20,000	5.0	6.5-8.5	1,000	98**
1413	Lake J.B. Thomas	s/k	s/k	s/k	s/k	50	60	500	5.0	6.5-8.5	200	93
1414	Pedernales River		s/k	s/k	s/k	80	50	500	5.0	6.5-8.5	1,000	98
1415	Llano River		s/k	s/k	s/k	50	50	300	5.0	6.5-8.5	1,000	98
1416	San Saba River	s/k	s/k	s/k	s/k	80	50	500	5.0	6.5-8.5	200	95
1417	Pecan Bayou - Colorado River confluence to Lake Brownwood Dam		s/k	s/k	s/k	250	200	1,000	5.0	6.5-8.5	1,000	95

* Standards to be reviewed upon completion of Corps of Engineers' Colorado River Study, if necessary

**Subject to revision

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

TEXAS WATER QUALITY BOARD
PROPOSED STREAM STANDARDS
APRIL 1973

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE N/A | PLATE IV-3

PROPOSED WATER QUALITY STANDARDS
FRESH & TIDAL WATERS

COLORADO RIVER BASIN — SEGMENT NUMBER	DESCRIPTION	WATER USES QUALITY DEEMED SUITABLE/ KNOWN USES: CONTACT RECREATION	NON-CONTACT RECREATION	PROPAGATION OF FISH & WILDLIFE	DOMESTIC RAW WATER SUPPLY	CRITERIA: CHLORIDE (mg/1) avg. not to exceed	SULPHATE (mg/1) avg. not to exceed	TOTAL DISSOLVED SOLIDS (mg/1) avg. not to exceed	DISSOLVED OXYGEN (mg/1) not less than	pH RANGE	COLIFORM: FECAL/ (100ml) - log. avg. not more than (see Gen. Statement)	TEMPERATURE °F (see Gen. Statement)
1418	Lake Brownwood	s/k	s/k	s/k	s/k	100	100	500	5.0	6.5-8.5	200	93
1419	Lake Coleman	s/k	s/k	s/k	s/k	100	100	500	5.0	6.5-8.5	200	93
1420	Pecan Bayou - above Lake Brownwood	s/k	s/k	s/k		500	500	1,500	5.0	6.5-8.5	200	90
1421	Concho River - Colorado River confluence to fork in San Angelo, including South Fork to Lake Nasworthy Dam and North Fork to San Angelo Reservoir Dam		s/k	s/k	s/k	600	500	2,000	5.0	6.5-8.5	1,000	95
1422	Lake Nasworthy	s/k	s/	s/k		450	400	1,500	5.0	6.5-8.5	200	93
1423	Twin Buttes Reservoir	s/k	s/k	s/k	s/k	150	150	700	5.0	6.5-8.5	200	** 93
1424	South and Middle Concho Rivers -above Twin Buttes Reservoir	s/k	s/k	s/k	s/k	150	150	700	5.0	6.5-8.5	200	90
1425	San Angelo Reservoir	s/k	s/k	s/k	s/k	150	150	700	5.0	6.5-8.5	200	** 93

* Standards to be reviewed upon completion of Corps of Engineers Colorado River Study, if necessary

** Subject to revision.

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

TEXAS WATER QUALITY BOARD
PROPOSED STREAM STANDARDS
APRIL 1973

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE N/A | PLATE IV-4

The chemical parameters, total dissolved solids (TDS), chlorides, and sulfates, presented in the 1973 proposed standards reflect the naturally-occurring salt contamination experienced in many of the streams in the western areas of Region III. The proposed stream standards increase the mean annual concentrations of the TDS, chlorides, and sulfates above Silver, Texas. However, the proposed standard for the main stream between Silver and the headwaters of Lake Buchanan, the first lake of the Highland Lakes chain, exhibit a step transition which resembles the trend of the measured chemical parameters for this area.

The bacteriological stream standards presented in the 1967 and 1973 proposed standards are similar and reflect generally acceptable levels for most uses of public waters.

Existing Water Quality.

Water Quality Data.

Evaluation of the quality of the water in a stream or reservoir can be accomplished by several methods. One method is to develop and instigate an intensive stream monitoring program for the area under study. The second approach is to review existing stream quality data collected by Federal, State and local agencies.

The first technique has many advantages. A monitoring program can be developed to collect pertinent and relevant data for the study at hand cognizant of previously collected monitoring data. Utilizing existing water quality data, as well as local public input , problem areas or areas of public concern can be defined and the stream monitoring program tailored to produce the needed information for evaluating the quality of the water in the stream or reservoir. This monitoring program addresses the parameters of interest and provides relevant data for evaluating existing water quality and projecting the impact of future discharges on the stream or reservoir.

The disadvantages to this approach are the cost and time required to put a large monitoring program into operation. Also the statistical validity of the monitoring data increases with the period of time data are collected. Therefore, an intensive monitoring program for one year may not reveal the critical water quality condition that can exist in the stream.

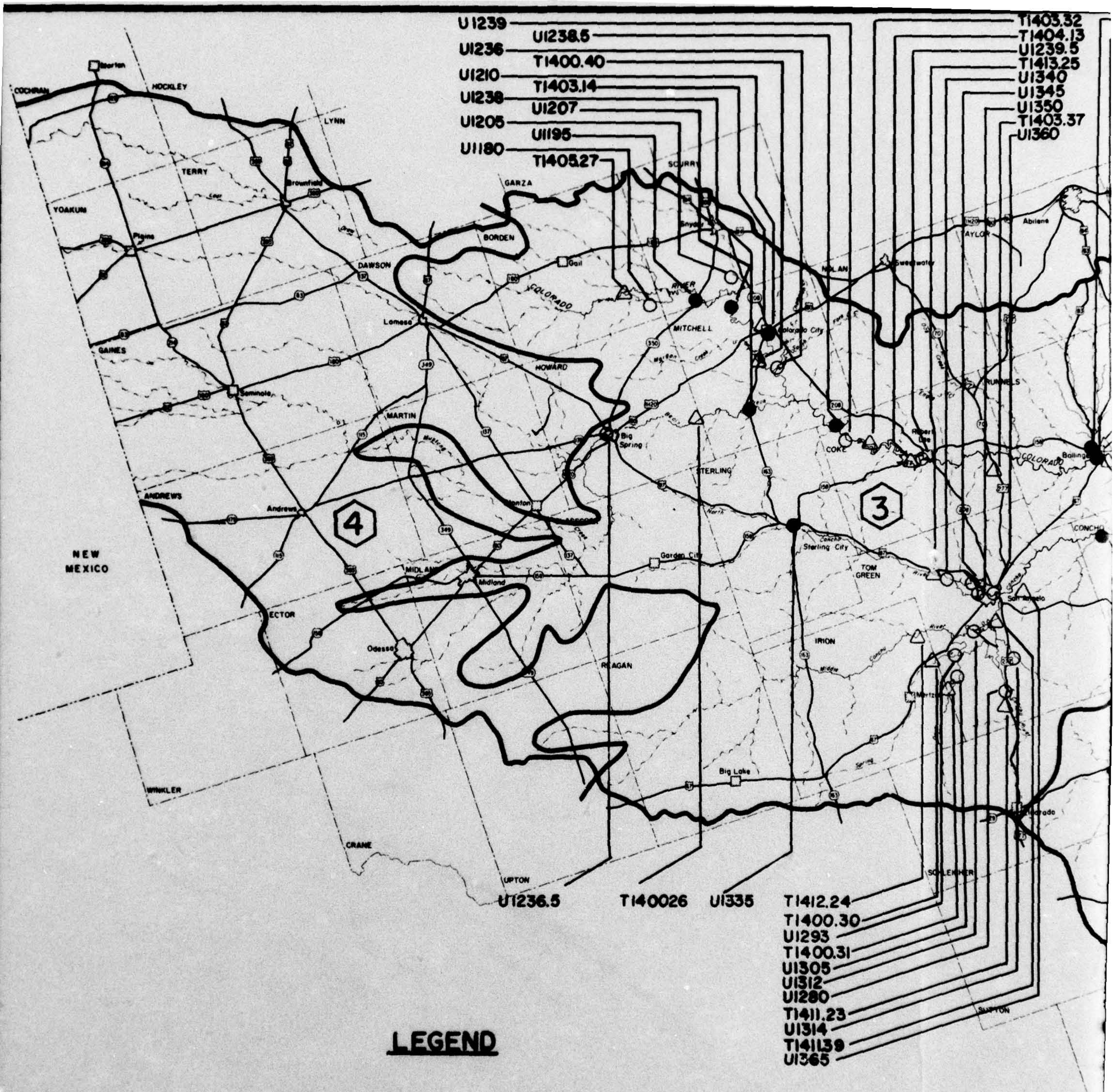
The other method of evaluating the water quality of a stream or reservoir is to utilize existing data collected and reported by Federal, State and local agencies. There are presently several agencies maintaining monitoring stations on the Colorado River and major tributaries. These agencies are the United States Geological Survey (USGS), Texas Water Quality Board (TWQB) and Texas State Department of Health (TSDH). The location of the USGS and TWQB monitoring stations are presented on Plate IV-5. TSDH monitoring stations are located on Plate IV-8.

Availability of Water Quality Data.

The USGS has maintained surveillance of the Colorado River at various monitoring stations since 1948. The majority of these monitoring stations serve as points for collecting "grab samples." Some parameters, such as temperature and conductance, are monitored continuously at a few select stations. USGS personnel periodically collect the grab samples for shipment to the nearest USGS laboratory. The results of the chemical analysis are published annually as "Water Resources Data for Texas, Water Quality Records." The frequency of sample collection appears to be seasonal. Fewer samples are collected in the winter months of December, January and February than the spring and summer months.

The USGS performs chemical analysis on a routine basis and biochemical analysis on samples collected for that purpose. Chemical parameters commonly reported include bicarbonate, carbonate, chloride dissolved solids, flouride, nitrate, phosphate, temperature, and others. Prior to 1968 chemical parameters were reported as parts per million and temperature as degrees Fahrenheit. Presently, chemical parameters are reported as milligrams per liter and temperatures as degrees Celsius (centigrade).

The Texas Water Quality Board began monitoring the streams of Texas in September 1968. TWQB personnel routinely collect one stream sample per month for laboratory analysis. Laboratory results are reported for pH, conductivity, total dissolved solids, 5-day biochemical oxygen demand, chlorides, and sulfates. Further field measurements are reported for temperature, turbidity, and dissolved oxygen. The laboratory and field results are recorded on computer tapes and printouts are available upon request.



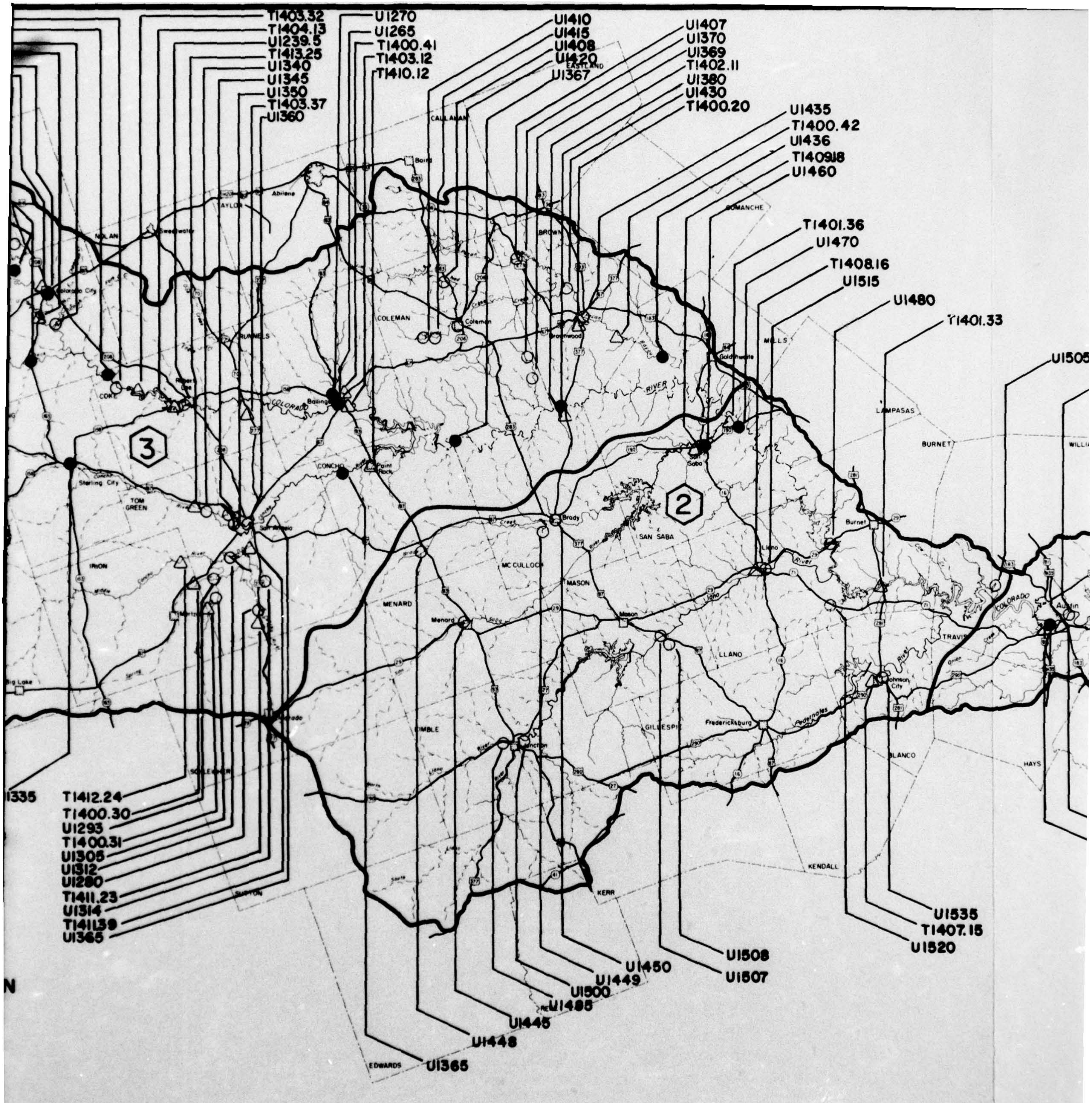
LEGEND

○ U1234-U.S.G.S. STREAMFLOW STATION

● U1234-U.S.G.S. QUALITY STATION

△ T1234-T.W.Q.B. QUALITY STATION

4 HYDROLOGIC SUB REGION



T1403.32
T1404.13
U1239.5
T1413.25
U1340
U1345
U1350
T1403.37
U1360
U1270
U1265
T1400.41
T1403.12
T1410.12
U1410
U1415
U1408
U1420
U1367
U1407
U1370
U1369
T1402.11
U1380
U1430
T1400.20
U1435
T1400.42
U1436
T1409.18
U1460
T1401.36
U1470
T1408.16
U1515
U1480
T1401.33
U1505
CALLAHAN
EASTLAND
TAYLOR
NOLAN
COMANCHE
BROWN
COLEMAN
RUNNELS
COKE
MILLS
LAMPASAS
BURNET
CONCHO
TOM GREEN
IRION
3
2
SAN SABA
MC CULLOCH
MENARD
MASON
LLANO
TRAVIS
KIMBLE
GILLESPIE
BLANCO
HAYS
KENDALL
KERR
SUTTON
SCHLEICHER
EDWARDS
COLORADO
RIVER
Baird
Abilene
Sweetwater
Colorado City
Coleman
Brownwood
Goldthwaite
Ballinger
Sterling City
Point Rock
Brady
Menard
Mason
Llano
Burnet
Austin
Fredericksburg
Johnson City
Big Lake
U1335
T1412.24
T1400.30
U1293
T1400.31
U1305
U1312
U1280
T1411.23
U1314
T1411.39
U1365
U1535
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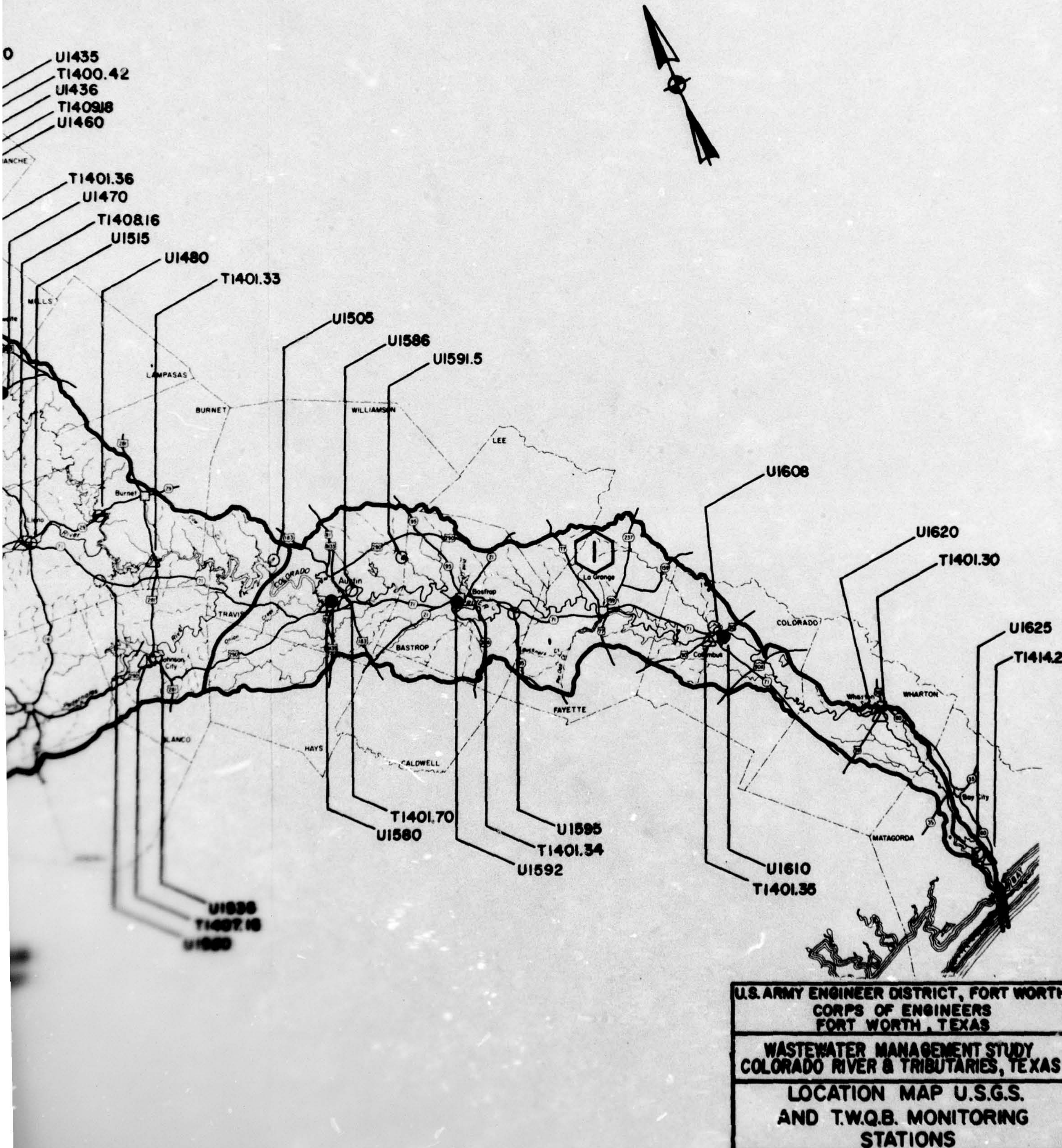
U1449
U1500
U1485
U1445
U1448
U1365

2



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

LOCATION MAP U.S.G.S. AND T.W.Q.B. MONITORING STATIONS

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 25 Miles	PLATE IV-5

Bacteriological monitoring of the Basin streams is performed by Texas State Department of Health. TSDH personnel periodically collect stream samples for laboratory analysis. These laboratory analyses are for total and fecal coliform and are reported as Most Probable Number per 100 ml. The results of the bacterial monitoring are stored on computer tape with copies available upon request.

Incorporating the vast quantities of available data into a useful condensed format for evaluation of existing water quality presents some difficulties. The erratic frequency of collection of chemical water quality samples invalidates averaging techniques. In an averaging technique, the greater number of summer samples may cause a one-sided value not necessarily reflecting the actual chemical quality of the stream.

Another difficulty in evaluating data from the three previously discussed sources is the inconsistency of sampling station locations of the agencies. Each agency has selected stream monitoring stations independently. Coincidence of location of sampling stations is probably associated with a convenient location such as a bridge over the stream.

Evaluation Techniques for Water Quality Data.

Water quality data evaluation and presentation were accomplished, cognizant of the susceptibility of the data to erroneously indicate the condition of the stream. These data should be reviewed to evaluate water quality trends. USGS chemical water quality data and mean monthly temperature extremes are presented for the main stream Colorado River, while all Biochemical Oxygen Demand (BOD_5) and Dissolved Oxygen (DO) values are from TWQB field analyses. Further, TWQB maintains the most consistent monitoring network on the six major tributaries; therefore, TWQB data were evaluated for the tributaries. Bacteriological data from TSDH were developed for most of the stations sampled.

The USGS published data for the Colorado River Basin were reviewed to determine the significance of the information. Monitoring stations were reviewed, based on the length of time stream sampling data had been collected. The selection of representative chemical data was in regard to locations of the monitoring stations on the river and compatibility with TWQB stream monitoring stations.

A review of the chemical parameters reported by USGS reveals that three are significant with regard to stream standards presently under consideration. These are chlorides, sulfates, and total dissolved solids. There are 30 to 50 samples per year, with some stations having in excess of 25 years of record. USGS tabulates and reports flow weighted averages for each water year of record. The arithmetic mean of these reported values has been tabulated for the various locations and presented on Plates IV-6 and 7.

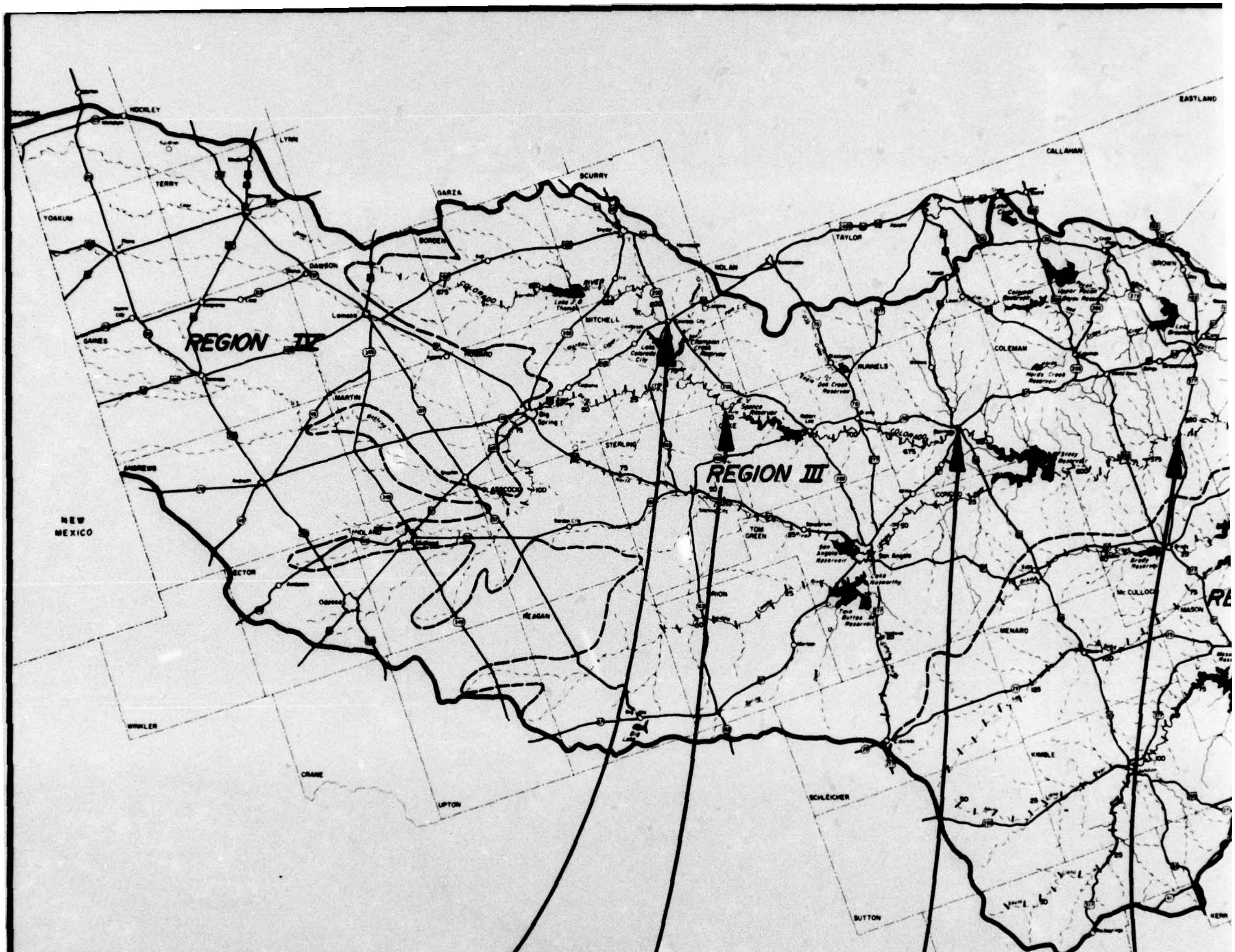
USGS reports daily temperature measurements and the monthly averages for each year of record. The monthly averages were reviewed for each year of data and the extreme values were tabulated for each station. The list of mean monthly extreme temperatures was then reviewed for the extreme values on record. These values are presented on Plates IV-6 and 7 and reflect the limits that water temperatures have been observed in the Colorado River.

The chemical water quality data presented on Plates IV-6 and 7 should be reviewed, cognizant of the meaning of averaging. There must be, by definition, values larger and smaller than the average. These chemical water quality data reflect changing trends which will be evaluated, by parameter, later in this section.

A review of the Texas Water Quality Board's stream sampling data reveals that stream samples are collected on a monthly basis. However, the sampling program has only been in effect since September 1968. At the time of this study, data were available for three complete years of sampling.

The TWQB's regular sampling frequency produces data that are compatible to statistical evaluation techniques. Field sampling data for BOD_5 and DO concentrations in the Colorado River, as well as all water quality data for the major tributaries except temperature, were evaluated for frequency or probability of occurrence. Temperature data did not lend to valid statistical evaluation due to the wide variance that could be affected in the data by the variation in the time of year at which measurements were taken and the fact that criteria for temperature are based on variation of stream temperature.

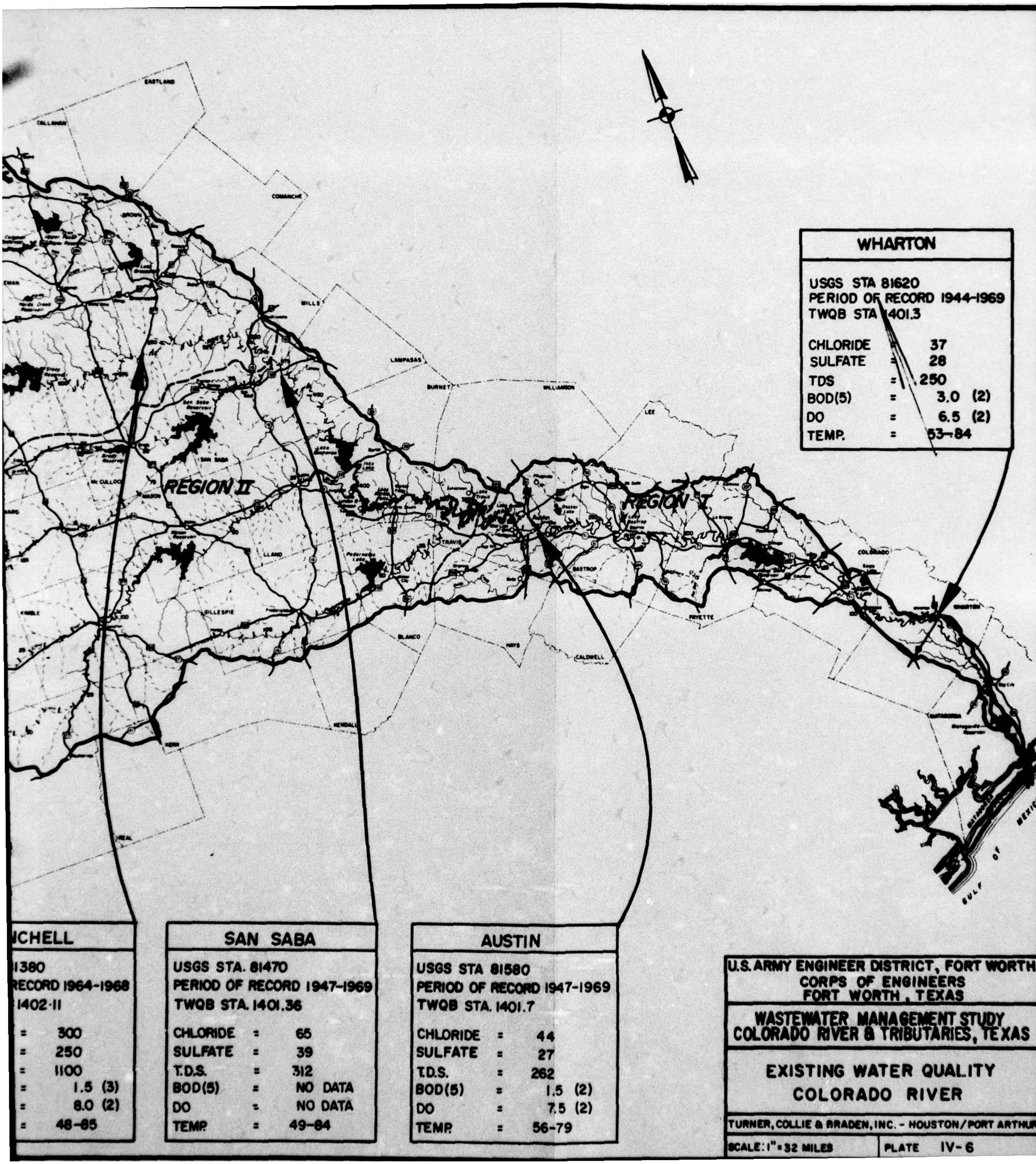
The statistical evaluation was accomplished by taking a family of data on each parameter and ranking the individual data values by magnitude, beginning with the smallest value. A percentile was then calculated, based upon the summation of the number of occurrences within each family. A plot of the family of data values versus the probability or frequency of occurrence produced a straight line if the data were arithmetically normal.

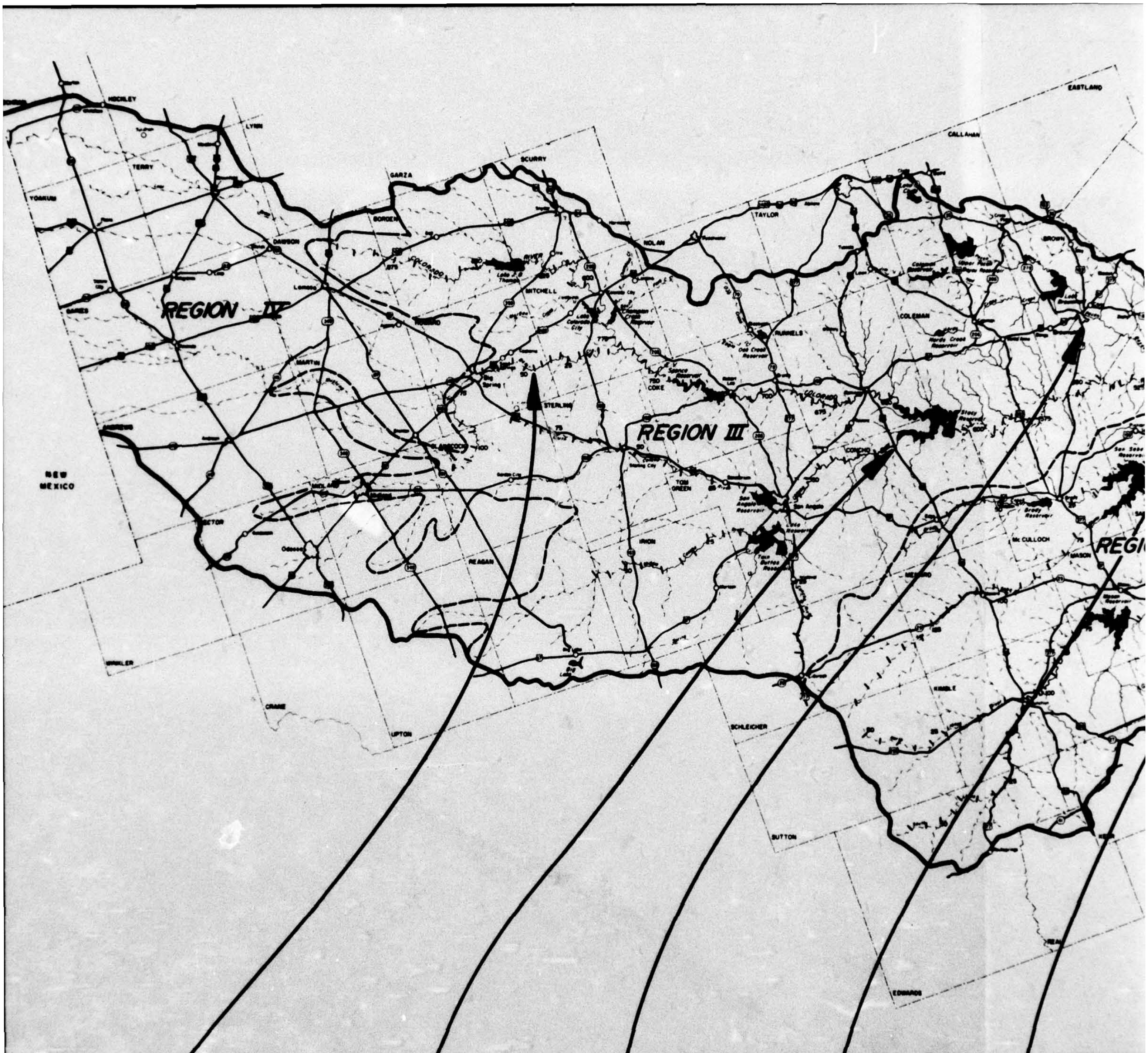


NOTES: REFER TO TEXT FOR DEFINITION OF VALUES. CHEMICAL AND BIOCHEMICAL VALUES EXPRESSED AS MG/L. TEMPERATURE RANGES REPORTED AS °F.

1. DATA ARITHMETICALLY NORMAL
2. DATA GEOMETRICALLY NORMAL
3. DATA ERRATIC, VALUE IS ORDER OF MAGNITUDE

	COLORADO CITY	SILVER	BALLINGER	WINCHELL
USGS STA.	81210	81239	81265	81380
PERIOD OF RECORD	1946-1969	1956-1969	1961-1969	1964-1968
TWQB STA.	1403.14	1403.32	1403.12	1402·11
CHLORIDE	= 780	= 375	= 210	= 300
SULFATE	= 160	= 150	= 130	= 250
T.D.S.	= 1630	= 935	= 650	= 1100
BOD(5)	= 4.0 (3)	= 3.5 (2)	= 2.0 (3)	= 1.5 (3)
DO	= 8.0 (3)	= 8.5 (2)	= 8.0 (2)	= 8.0 (2)
TEMP.	= 48-88	= 44-81	= 46-84	= 48-85


EASTLAND
CALLAHAN
COMANCHE
BROWN
MILLS
LAMPASAS
BURNET
WILLIAMSON
LEE
SAN SABA
REGION II
REGION I
MASON
LLANO
TRAVIS
BASTROP
GILLESPIE
BLANCO
HAYS
CALDWELL
FAYETTE
COLORADO
WHARTON
MATAGORDA
KENDALL
KERR
REAL
KIMBLE
GULF OF MEXICO
WHARTON
USGS STA 81620
PERIOD OF RECORD 1944-1969
TWQB STA 1401.3
CHLORIDE = 37
SULFATE = 28
TDS = 250
BOD(5) = 3.0 (2)
DO = 6.5 (2)
TEMP. = 53-84
CHELL
1380
RECORD 1964-1968
1402·11
= 300
= 250
= 1100
= 1.5 (3)
= 8.0 (2)
= 48-85
SAN SABA
USGS STA. 81470
PERIOD OF RECORD 1947-1969
TWQB STA. 1401.36
CHLORIDE = 65
SULFATE = 39
T.D.S. = 312
BOD(5) = NO DATA
DO = NO DATA
TEMP. = 49-84
AUSTIN
USGS STA 81580
PERIOD OF RECORD 1947-1969
TWQB STA. 1401.7
CHLORIDE = 44
SULFATE = 27
T.D.S. = 262
BOD(5) = 1.5 (2)
DO = 7.5 (2)
TEMP. = 56-79
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
EXISTING WATER QUALITY
COLORADO RIVER
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE: 1" = 32 MILES
PLATE IV-6



BEALS CREEK
T.W.Q.B 1400.26

CHLORIDE(3)	= 1500
SULFATE (3)	= 1200
T.D.S. (3)	= 4000
D.O. (2)	= 6.5
BOD. (3)	= 9.0
TEMP.	= 50-79

CONCHO RIVER
U.S.G.S 81365 T.W.Q.B. 1410.21

CHLORIDE (3)	= 450
SULFATE (3)	= 300
T.D.S. (3)	= 1800
D.O. (2)	= 8.0
B.O.D. (3)	= 2.5
TEMP.	= 42-79

PECAN BAYOU
T.W.Q.B. 1400.20

CHLORIDE(3)	= 100
SULFATE (3)	= 65
T.D.S. (3)	= 450
D.O. (2)	= 7.0
B.O.D. (2)	= 1.5
TEMP.	= 44-85

SAN SABA RIVER
T.W.Q.B. 1409.18

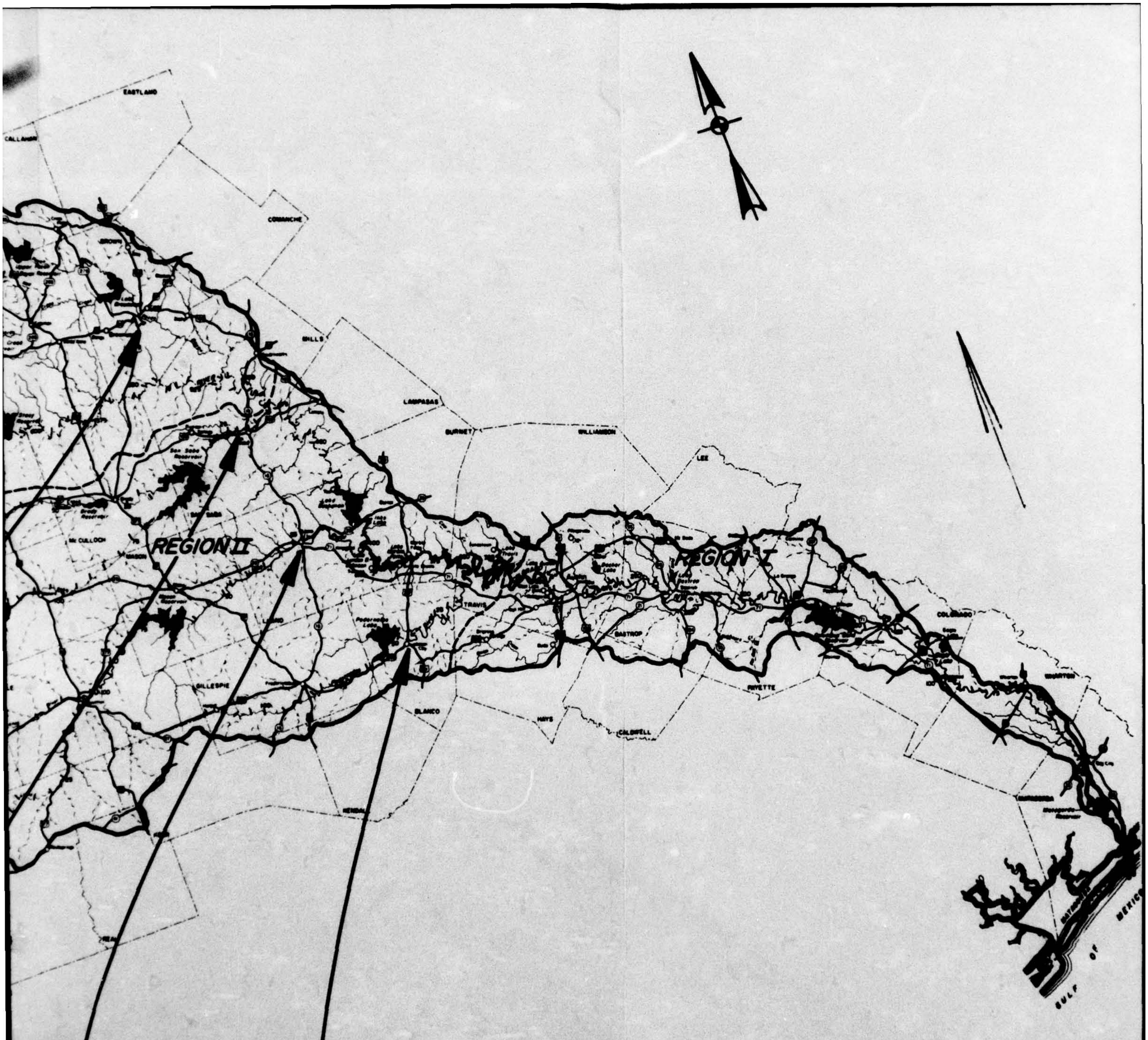
CHLORIDE(3)	= 20
SULFATE (3)	= 18
T.D.S. (3)	= 350
D.O. (2)	= 7.5
B.O.D. (2)	= 1.5
TEMP.	= 43-83

LLANO RIVER
T.W.Q.B. 1408.16

CHLORIDE(3)	= 25
SULFATE (3)	= 15
T.D.S. (2)	= 250
D.O. (2)	= 8.0
B.O.D. (2)	= 1.0
TEMP.	= 46-85

PEDERNA
T.W.Q.B.

CHLORIDE (	
SULFATE (	
T.D.S. (	
D.O. (	
B.O.D. (	
TEMP.	



RIVER	1408.16
):	25
):	15
):	250
):	8.0
):	1.0
=	46-85

PEDERNALES RIVER T.W.Q.B.		1407.15
CHLORIDE (2)	=	55
SULFATE (3)	=	25
T.D.S. (2)	=	250
D.O. (2)	=	9.0
B.O.D. (2)	=	1.5
TEMP.	=	48-83

NOTES: FOR DEFINITION OF VALUES SEE REPORT TEXT. CHEMICAL AND BIOCHEMICAL VALUES ARE EXPRESSED AS MG/L. TEMPERATURE RANGES ARE EXPRESSED AS °F.

(1) DATA ARITHMETICALLY NORMAL

(2) DATA GEOMETRICALLY NORMAL

(3) DATA ERRATIC, VALUE IS ORDER OF MAGNITUDE

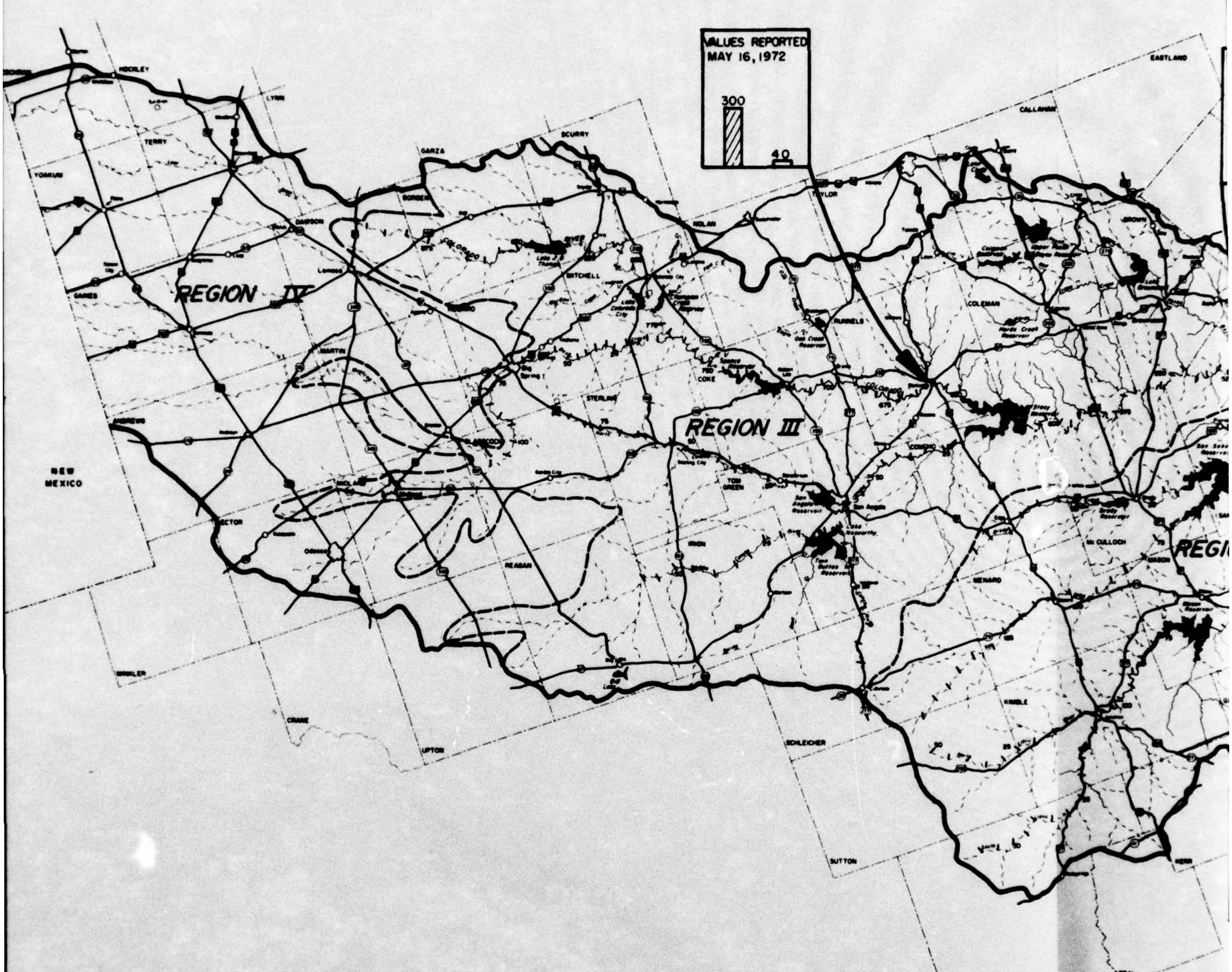
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

EXISTING WATER QUALITY
MAJOR TRIBUTARIES

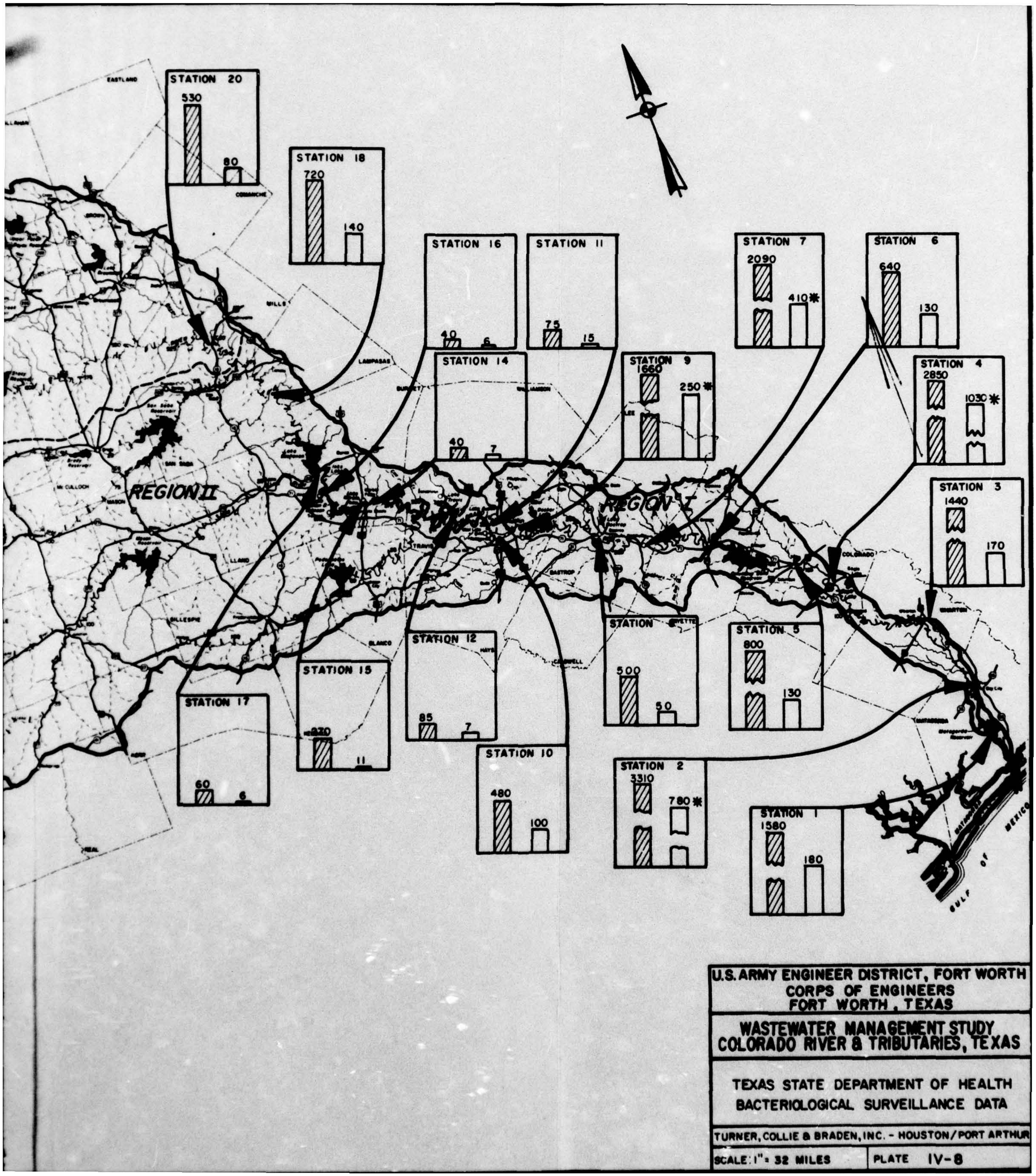
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 32 MILES | PLATE IV-7



LEGEND

- LOGARITHMIC MEAN TOTAL COLIFORM (MPN/100ML)
- LOGARITHMIC MEAN FECAL COLIFORM (MPN/100ML)
- * VALUES EXCEED T.W.Q.B. STREAM STANDARDS FOR CONTACT RECREATION


STATION 20
530
80
STATION 18
720
140
STATION 16
40
6
STATION 11
75
15
STATION 7
2090
410*
STATION 6
640
130
STATION 14
40
7
STATION 9
1660
250*
STATION 4
2850
1030*
STATION 3
1440
170
REGION II
REGION I
STATION 17
60
6
STATION 15
270
11
STATION 12
85
7
STATION 10
480
100
STATION 8
500
50
STATION 5
800
130
STATION 2
3310
780*
STATION 1
1580
180
GULF OF MEXICO
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
TEXAS STATE DEPARTMENT OF HEALTH
BACTERIOLOGICAL SURVEILLANCE DATA
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE: 1" = 32 MILES
PLATE IV-8

the Ballinger monitoring station have been 4,200 mg/l, 1,680 mg/l and 1,060 mg/l, respectively.

The San Saba monitoring station, with 22 years of data reviewed, provides the most statistically reliable comparison to the Colorado City station. The maximum recorded TDS, chloride and sulfate concentrations have been 2,440 mg/l, 1,000 mg/l and 500 mg/l, respectively, substantiating the trend of decreasing chemical parameters as the main stream flows from Region III.

The chemical parameters continue to be diluted as additional tributaries contribute to the flow. The stream monitoring station at Wharton reflects this trend with maximum TDS, chloride and sulfate concentrations of 400 mg/l, 107 mg/l and 57 mg/l, respectively.

Beals Creek, a major tributary in Region III, exhibits the trend of high values for TDS, chlorides and sulfates observed in the main stream. The reported data reflect only three years of monthly sampling and should not be directly compared with the values presented for the main stream. Beals Creek has maximum reported TDS, chloride and sulfate concentrations of 14,800 mg/l, 4,500 mg/l and 2,700 mg/l, respectively.

The Concho River reflects a lower concentration of the chemical parameters as exemplified by a maximum recorded TDS concentration of 2,040 mg/l.

The remaining tributaries exhibit significantly lower chemical parameters than the main stream Colorado River. The maximum reported TDS for Pecan Bayou, San Saba, Llano and Pedernales Rivers has been 600 mg/l, 390 mg/l, 290 mg/l, and 290 mg/l, respectively.

A chemical parameter which has not been discussed previously, that merits mention is the nitrate level of the Colorado River. Nitrates are measured routinely only in the main stream. The highest nitrate concentration recorded has been 26 mg/l and was observed at the Ballinger sampling station. A nitrate concentration of 45 mg/l has been established as the limit for raw public water supplies by the Public Health Service [2]. Nitrate levels of the Colorado River have not approached this limit.

A water quality parameter that has recently generated public concern is water temperature. Temperature measurements for the Colorado River follow seasonal trends. The shallow depth of the upper reaches exhibit a wider temperature fluctuation associated with the seasonal ambient temperature. Example of this trend can be depicted by comparing the mean

monthly temperature extremes at the Colorado City and Wharton monitoring stations. Colorado City monitoring station data have a seasonal mean monthly temperature extreme variation of 40°F, while the seasonal mean monthly temperature extreme variation recorded at the Wharton monitoring station is 31°F.

The major tributaries have such limited temperature data it is not reliable to compare these values with the main stream. The limited data indicate that seasonal variations in the major tributaries will be similar to the variations experienced in the main stream of the Colorado.

Reviewing the bacteriological data on the Colorado River reveals that only one monitoring station has been maintained in Region III. TSDH station No. 20, located on the river near the division of Regions II and III is the furthest upstream station where consistent bacteriological sampling has been practiced.

The coliform data reported for the main stream indicate that low concentrations of total and fecal coliform exist in the Colorado River in Region II.

The total and fecal coliform recorded data exhibit a marked increase in the Colorado River in Region I. The trend can be observed as beginning below the City of Austin. The geometric mean MPN values fluctuate; however, the predominant trend has been an overall higher concentration of total and fecal coliform in the Colorado River in Region I.

Water Quality of Impoundments.

There are numerous man-made impoundments on the Colorado River and tributaries. These impoundments have been constructed to provide flood protection, raw drinking water supply, hydroelectric power, electric generation cooling water, and agricultural irrigation water. They range in size from Lake Travis, with a usuable storage capacity of 1,144,100 acre-feet, to Town Lake, with a storage capacity of 3,520 acre-feet.

The major reservoirs located in the Colorado River Basin exhibit thermal stratification during the warm summer months and can be classified as warm monomictic lakes [3]. The quality of the water in these reservoirs is a function of several variables.

A significant determination of the water quality of a reservoir is the quality of the streams flowing into the impoundment. This is a function of natural and man-made contributions, as discussed in the previous section.

Another significant factor that may affect the water quality of an impoundment will be the type of development that occurs along the shoreline. A large suburban development that relies upon individual home septic tanks may create an undesirable situation that allows partially treated sewage to reach the reservoir [4]. Similarly, industrial wastewater discharges may reduce the water quality through releases toxic to the aquatic life or that possess undesirable taste characteristics for public water supplies.

In addition, water quality varies seasonally as thermal stratification develops. The density gradient produced by the temperature change, or salts, presents an effective barrier to mixing. During periods of stratification, the impoundment is a three-layer system. Biological activity, particularly algae and aquatic weeds, will influence the chemical characteristics within these layers. Gradations with depth have been observed for dissolved oxygen, pH, hardness, alkalinity, phosphorus, nitrogen and other nutrients [5]. Coliform organisms usually decrease in a reservoir due to an unfavorable environment.

The Colorado River has a series of continuous impoundments, located primarily in Burnet and Travis counties in Region II, referred to as the Highland Lakes. The Highland Lakes consist of Lake Buchanan, Inks Lake, Lake Lyndon B. Johnson and Marble Falls Lake in Burnet County, as well as Lake Travis, Lake Austin and Town Lake in Travis County.

The Highland Lakes have been investigated for a number of year by various personnel of the Center for Research in Water Resources, University of Texas at Austin. Numerous reports, publications and theses have been prepared from these studies, with a final report published summarizing the previous works. The final report, by Fruh and Davis [5], presents a summary of field investigations of chemical, biological, and thermal changes in water quality of the Highland Lakes.

The report identifies oxygen depletion of the hypolimnetic waters, after the initiation of seasonal temperature stratification, as the significant water quality change in southwestern impoundments. The report also identifies both nitrogen and phosphorus as limiting nutrients in the Highland Lakes [6]. The low level of nutrients presently in the waters of the Highland Lakes retards the growth of algal crops.

Town Lake, and Lake Austin to a lesser degree, exhibit the effects of urban runoff from the City of Austin [7]. A review of the water quality changes of the raw water supply of the City of Austin Water Treatment Plant No. 1 shows that bacterial concentrations in Town Lake have increased since 1945. This is attributed primarily to increased pollution of Town Lake by urban runoff [8].

The numerous other impoundments within the Colorado River Basin will experience similar thermal stratification and hypolimnetic oxygen depletion. The algal crop of other impoundments will be a function of the available nutrients. A primary source of nutrients in streams has been attributed to domestic wastewater effluents [9]. The presence of man-introduced nutrients will accelerate the natural eutrophication of lakes, creating a degradation of the water quality.

Ground Water Quality.

Located within the Colorado River Basin are two aquifers, the Ogallala and Edwards-Trinity (Plateau), that are capable of yielding large quantities of water over large areas. In addition to these two major aquifers, there are seven additional aquifers: Edwards-Trinity (High Plains), Edwards (Balcones Fault Zone), Santa Rosa, Ellenburger-San Saba, Hickory, Carrizo-Wilcox and Gulf Coast, which are capable of yielding large quantities of water over relatively small areas.

It has been estimated that approximately 57,000,000 acre-feet of ground water [10] of a chemical quality suitable for municipal, industrial and agricultural uses may be available in the major and minor aquifers of the Colorado River Basin.

A review of published chemical analysis of ground water samples collected from wells located throughout the Basin reveals that wide ranges of quality can exist in ground water from the same aquifer.

The primary aquifer of Region IV--Ogallala--exhibits wide fluctuations in quality. The total dissolved solids can range from several hundred to several thousand parts per million. The fluoride concentration of these ground waters generally exceeds 0.8 mg/l, which is considered the safe limit for public water supply.

The trend in water quality of this aquifer has been a decrease in TDS with an increase in the water depth. Therefore, water wells are generally drilled to the base of the aquifer in Region IV.

Two primary aquifers exist in Region III. The Ogallala Aquifer is present in the western area, with the Edwards-Trinity (Plateau) underlying the majority of Region III. Water quality of the Ogallala Aquifer does not vary from that in Region IV. The Edwards-Trinity (Plateau) Aquifer exhibits wide variations in quality, ranging from unsuitable for municipal and industrial use to uniformly good quality.

Water from the Edwards-Trinity (Plateau) in the northwestern area of Region III has a high mineral content with TDS concentrations reported as high as 3,500 mg/l. The water also exhibits excessive hardness and sulfate properties which make it unsuitable for domestic and industrial use.

The majority of Region III receives a good quality of water from the Edwards-Trinity (Plateau) Aquifer. The TDS concentration varies from 200 to 700 mg/l. The water exhibits a hardness of 120 to 180 mg/l expressed as equivalents of calcium carbonate, but otherwise has a uniform acceptable quality.

The secondary aquifers in Region III follow the trend of the Edwards-Trinity (Plateau) Aquifer. Generally, the secondary aquifers have a slightly higher TDS level, but can still be utilized for municipal and industrial supplies.

Region II has the Edwards-Trinity (Plateau) Aquifer underlying the area. The water quality characteristics remain the same as presented for Region III, with the exception of the northwestern corner of Region III.

Region II has two secondary aquifers, Ellenburger-San Saba and Hickory, which ring the geological formation referred to as the Llano Uplift, which is centered in Llano County. Water quality of these aquifers in the outcrop areas follows the trend of the Edwards-Trinity (Plateau) with high hardness, but suitable for municipal and industrial use. The downdip areas of these aquifers have excessive mineral concentrations and are generally unacceptable for municipal and industrial supply.

Region I of the Colorado River Basin does not have a primary aquifer underlying the area. Two secondary aquifers, Gulf Coast and Carrizo-Wilcox, comprise the underlying ground water sources.

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WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEX--ETC(U)
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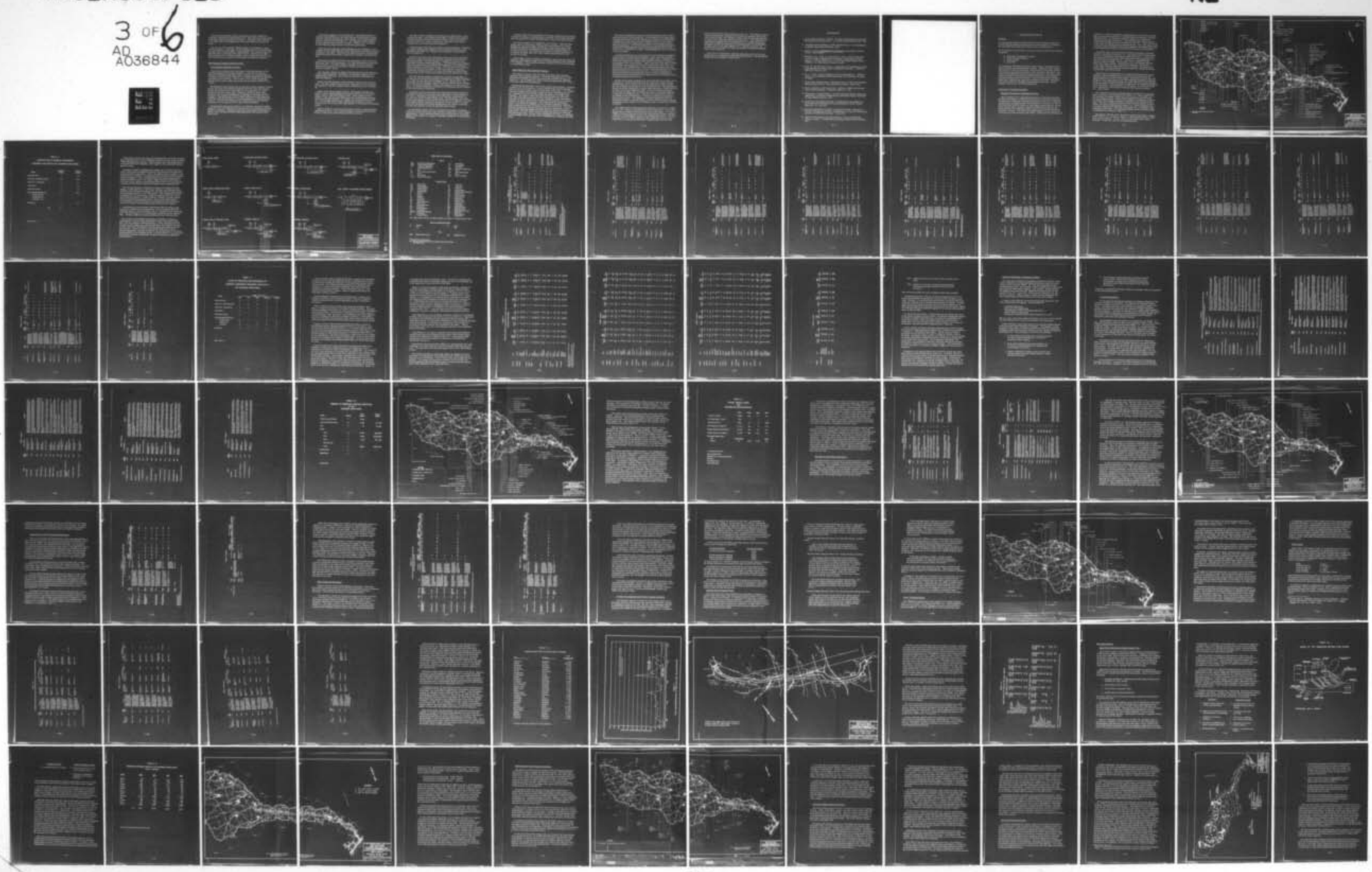

The Gulf Coast Aquifer yields a good quality of water suitable for municipal, industrial and agricultural uses. The presence of iron creates some taste problems at sporadic locations. Generally, water with 200 to 700 mg/l TDS, low hardness and iron can be found near 500 feet of depth.

The Carrizo-Wilcox Aquifer exhibits higher concentrations of iron, TDS and hardness. Generally, the total hardness and iron concentrations decrease with increasing depth. Total hardness for this aquifer has been reported from 5 to 460 mg/l with TDS of 200 to 1,000 mg/l recorded. Water from the Carrizo-Wilcox Aquifer can be treated to reduce the iron and total hardness as required for municipal and industrial supplies.

Water Quality Problems within the Basin.

Water Quality Standards Violation.

The previous sections have presented a review and summary of the 1967 and proposed 1973 stream standards, as well as a review and summary of existing water quality data. Evaluation of stream standards violations will focus on the proposed 1973 stream standards with reference to pertinent 1967 standards. The locations of the various monitoring stations used in these comparisons have been presented on Plates IV-6, 7 and 8.

Reviewing the water quality data for the main stream in Region I reveals that the DO level at the Wharton sampling station for both 1967 and proposed 1973 standards has a probability of occurring below the 5 mg/l standard ten percent of the time. Similarly, the BOD_5 level of the stream has an 18 percent probability of equaling or exceeding the 1967 standard. The monitoring station at Austin reflects a greater degree of compliance with the proposed 1973 stream standards as reflected by the DO level. The DO concentration of the stream has only a one percent probability of occurring below the 5 mg/l stream standard.

The geometric mean fecal coliform concentrations exceed the stream standard of 200 LOG MPN/100 ml level for contact recreation at numerous locations in Region I. Adequate disinfection of wastewater discharges in Region I would probably improve these undesirable total and fecal coliform levels.

Two primary aquifers exist in Region III. The Ogallala Aquifer is present in the western area, with the Edwards-Trinity (Plateau) underlying the majority of Region III. Water quality of the Ogallala Aquifer does not vary from that in Region IV. The Edwards-Trinity (Plateau) Aquifer exhibits wide variations in quality, ranging from unsuitable for municipal and industrial use to uniformly good quality.

Water from the Edwards-Trinity (Plateau) in the northwestern area of Region III has a high mineral content with TDS concentrations reported as high as 3,500 mg/l. The water also exhibits excessive hardness and sulfate properties which make it unsuitable for domestic and industrial use.

The majority of Region III receives a good quality of water from the Edwards-Trinity (Plateau) Aquifer. The TDS concentration varies from 200 to 700 mg/l. The water exhibits a hardness of 120 to 180 mg/l expressed as equivalents of calcium carbonate, but otherwise has a uniform acceptable quality.

The secondary aquifers in Region III follow the trend of the Edwards-Trinity (Plateau) Aquifer. Generally, the secondary aquifers have a slightly higher TDS level, but can still be utilized for municipal and industrial supplies.

Region II has the Edwards-Trinity (Plateau) Aquifer underlying the area. The water quality characteristics remain the same as presented for Region III, with the exception of the northwestern corner of Region III.

Region II has two secondary aquifers, Ellenburger-San Saba and Hickory, which ring the geological formation referred to as the Llano Uplift, which is centered in Llano County. Water quality of these aquifers in the outcrop areas follows the trend of the Edwards-Trinity (Plateau) with high hardness, but suitable for municipal and industrial use. The downdip areas of these aquifers have excessive mineral concentrations and are generally unacceptable for municipal and industrial supply.

Region I of the Colorado River Basin does not have a primary aquifer underlying the area. Two secondary aquifers, Gulf Coast and Carrizo-Wilcox, comprise the underlying ground water sources.

The main stream of Region II has limited water quality data, as previously discussed. This limited stream data, as well as the numerous technical reports from the University of Texas, Center for Research in Water Resources, Austin, indicate that violations of the stream standards have not been measured in Region II.

Region III has a wide range of values for stream standards, reflecting the rapidly changing water quality as the main stream flows from the headwaters and Lake J. B. Thomas to the confluence of the San Saba River in Region II.

The DO level of this reach of the main stream has been consistently high with no reported stream DO standards violations at the Winchell monitoring station. One DO violation, a reading of 1.0 mg/l, was reported at the Silver monitoring station. The field data at the Ballinger monitoring station indicates that the DO standard has a probability of being violated only 4 percent of the time. The Colorado City monitoring station field data has been highly erratic and cannot be considered statistically reliable; however, a review of the field data of the TWQB indicates that the DO rarely drops below the stream standard of 5 mg/l.

The 1967 stream standards established a monthly average BOD_5 of 4.0 mg/l for the reach from San Saba to Ballinger and a monthly average of 5.0 mg/l for the reach from Ballinger to J. B. Thomas Dam. The BOD_5 data from the Ballinger monitoring station indicate that the stream has an 18 percent probability of BOD_5 value equal to or greater than 4.0 mg/l. The BOD_5 probability of equaling or exceeding the stream standard at Silver increases to 34 percent.

The BOD_5 and DO levels at the Silver monitoring station indicate the possibility of algae and/or aquatic weeds affecting the stream quality in this reach. The algae, when placed in a BOD bottle and incubated in the dark, will exert a positive BOD_5 value. This high BOD_5 value must be evaluated cognizant of the DO level at the time the sample was collected. Algae and/or aquatic weeds have been known to drive the DO of a stream above the saturation level during daylight hours and produce critically low DO concentrations during the night when they respire.

If a high BOD_5 and DO value are reported for a sample, it probably reflects a stream condition of large colonies of algae and/or heavy aquatic weed growth. These conditions further reflect the possibility of nutrient addition to the stream as a result of municipal,. industrial, or agriculture discharges.

A review of the 1967 and proposed 1973 stream standards for the major tributaries in Region II indicates that no violation of the stream standards has been reported for either the Pedernales, Llano or San Saba Rivers.

The major tributaries for Region III vary in quality. Existing water quality data for Pecan Bayou indicates that the proposed 1973 stream standard for dissolved oxygen concentration in the stream below Lake Brownwood Dam has a probability of being violated approximately 10 percent of the time. The Concho River reflects a similar probability of a violation of falling below the 5 mg/l standard approximately seven percent of the time.

Beals Creek, a major tributary in Region III, has no specific numerical standards established by either the 1967 stream standards or the proposed 1973 standards. Water quality problems of Beals Creek will be discussed in the following section.

Other Significant Water Quality Problems

There exist two areas in the Colorado River Basin that represent significant water quality problems. A problem with high levels of TDS, chlorides and sulfates has been observed in the northwestern areas of Region III. Also in Region III, Beals Creek has significantly high BOD_5 level and erratic DO concentrations.

Addressing the high TDS, chloride and sulfate concentrations, commonly referred to as a salt problem, it can be observed that the salt problem exists in the main stream of the Colorado River below Lake J. B. Thomas Dam and continuing downstream through the Silver monitoring station, E. V. Spence Reservoir, and the monitoring stations at Ballinger and Winchell. The origin of these salts has been disputed for some time. The Texas Railroad Commission [11] has identified various operational violations in the oil fields of the area as potential pollution sources from improper oil field brine disposal. The Texas Railroad Commission Report, reproduced in Appendix D of the Technical Appendix, indicates these violations have been corrected as they were discovered. The Texas Railroad Commission further notes that numerous abandoned oil wells have not been properly plugged and brine has been observed seeping from these wells. The well owners must be located and required to properly plug the leaking wells. Several of these abandoned oil wells are classified as "lost identity" wells and have been recommended for plugging with State funds.

Salt water contamination may be occurring through leaking oil wells below the surface of the ground [12]. This seepage may be appearing as a spring some distance from the leaking well. Instances of springs discharging high saline waters have been noted; however, it has not been possible to link these springs with a leaking oil well without extensive field investigations. At this time there has not been adequate field work completed to substantiate the cause of the saline springs in the northwestern area of Region III as either seeping plugged oil wells or naturally occurring springs.

A field investigation to locate and test for brine leakage of plugged oil wells would be a monumental undertaking. There exist numerous lost identity wells that would require outside funding to plug. Plugging of all known and located brine-seeping wells would not necessarily eliminate salt pollution of the surface water. There would still exist large numbers of abandoned brine disposal pits that would contribute salts to the overland runoff. The residual effect of salt contaminated ground water and springs would be noticed for years in areas where ground water movement has been measured as a few feet per year. It would be premature to propose solutions for eliminating the sources of salt contamination of the surface and ground waters in the northwestern area of Region III prior to determining the actual sources.

Another water quality problem area in the Colorado River Basin occurs in Region III. Beals Creek flows from the confluence of Sulfur Springs and Mustang Draw in Howard County in an easternly direction through the City of Big Spring and thence to the Colorado River. The Texas Water Quality Board has maintained a stream monitoring station (TWQB 1400.26) on Beals Creek since September 1968. A review of this stream data reveals that the BOD_5 value of Beals Creek has a 70 percent probability of equaling or exceeding 5 mg/l. Similarly, the DO of Beals Creek at the TWQB monitoring station has a 32 percent probability of equaling or falling below 5 mg/l. The significance of these reported data lies in the high probability of both the BOD_5 and the DO of Beals Creek violating established stream standards for the main stream Colorado River at their confluence.

The TWQB stream monitoring station (1400.26) is located at a bridge on F.M. 821, which is approximately 24 miles downstream of the City of Big Spring's wastewater treatment plant point of discharge. A review of TWQB's self-reporting data for the City of Big Spring reveals consistent violations of the parameters listed by the Waste Control Order. Further, a cursory review of USGS stream flow data (USGS 08123650) for Beals Creek above the Big Spring wastewater treatment plant indicates that

Beals Creek is a dry creek a majority of the year. The effluent from the Big Spring wastewater treatment plant therefore comprises most of the flow in Beals Creek. The effluent in Beals Creek travels approximately 68 miles to the confluence with the Colorado River. This confluence is approximately twenty miles above the pool of E. V. Spence Reservoir. Although it is difficult to project the biological impact of the high BOD_5 of Beals Creek on the water quality of E. V. Spence Reservoir, the nutrients associated with this BOD_5 may promote accelerated eutrophication of this reservoir.

Improvement of wastewater treatment operations at the City of Big Spring's plant, resulting in an improved effluent quality, will undoubtedly enhance the water quality of Beals Creek.

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10. Texas Water Development Board, "Reconnaissance Investigation of the Ground-Water Resources of the Colorado River Basin, Texas," Report No. 51, July 1967.

11. Railroad Commission of Texas, Oil and Gas Division, "Resume of Railroad Commission District's Investigation of Oil and Gas Production Leases in Colorado River Basin," July, 1972.

12. "Salt Water Pollution of the Colorado River, Scurry and Mitchell Counties, Texas," Colorado River Municipal Utility District, January 1961.

V. WASTEWATER SOURCES

General.

It is the purpose of this section of the report to present an inventory of current and anticipated wastewater sources and to quantify, if possible, the associated waste loads each exerts on the receiving waters.

For the purposes of discussion, all sources were divided into the following categories:

1. Wastewater Treatment Facilities
2. Water Treatment Plants
3. Urban Runoff
4. Non-Point

The wastewater treatment discussion includes data on municipal wastewater facilities and industrial waste sources. Industrial waste sources discussed are livestock operations, sand and gravel operations, thermoelectric power generation operations, heavy industrial operations, and commercial-industrial solid waste disposal facilities. The urban runoff portion includes a discussion of overland runoff and what stormwater collection systems exist in the Basin. The non-point portion includes a discussion of agricultural runoff and irrigation return flow, municipal solid waste facilities, individual sewage disposal facilities, natural pollution sources and oil-field contamination.

Wastewater Treatment Facilities.

Municipal Wastewater Treatment Facilities.

The development of a comprehensive inventory of existing municipal (domestic) wastewater treatment facilities was necessary to evaluate the current status of domestic wastewater treatment in the Basin. Baseline information on existing facilities was obtained by a review of the files of the Texas Water Quality Board, the State agency responsible for issuing waste control orders, and the Texas State Department of Health, the State agency which establishes design criteria for municipal wastewater treatment facilities. This data was supplemented by on-site inspection of seventy-six of the facilities in the Basin. These visits were performed

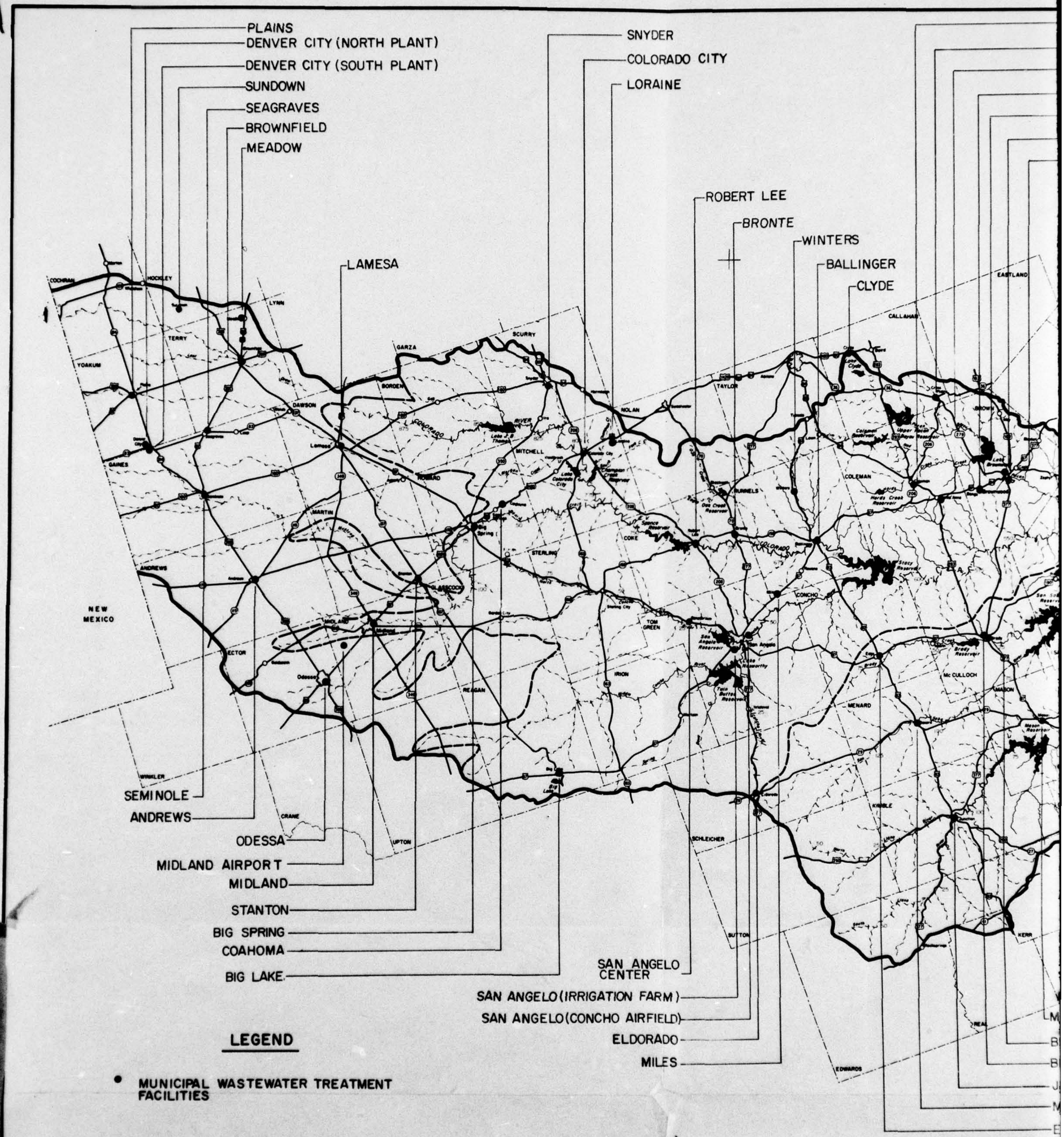
primarily to visually evaluate the existing facilities and obtain pertinent data on the facility performance, effluent disposal techniques, and other applicable data. No influent or effluent samples were collected in conjunction with these visitations. Self-reporting data supplied by the Texas Water Quality Board for the period of July 1971 - June 1972 served as the basis for effluent quality presented herein. Due to the general lack of proper flow measuring and monitoring equipment throughout the Basin, it was impossible to obtain current flow data on many of the facilities.

Currently, there are 87 permitted municipal wastewater treatment systems in the Basin (see Plate V-1). The areas served by these plants vary from community to the single commercial site (i.e., restaurant). Approximately 664,500 people, 80 percent of the Basin population, are served by these existing facilities which have a combined design capacity of about 95 mgd. The systems vary in size (design capacity) from 0.002 mgd to 40 mgd. Median plant capacity in the Basin is 0.1875 mgd, while the mean plant size is 1.09 mgd. This mean size varies from 2.76 mgd in the metropolitan areas to 0.49 mgd in the non-metropolitan areas of the Basin.

Twenty-three of the facilities are located in the metropolitan areas (SMSA's), which encompass about 10 percent of the Basin area and approximately 56.1 percent of the people. About 453,300 of the 525,600 people living in these areas are served by existing wastewater treatment facilities. The remaining 64 plants are rather sparsely located throughout the remainder of the Basin and currently serve an estimated population of 211,200 people. Approximately 170,300 people, or 20 percent of the Basin population, are served by individual waste disposal systems, i.e., septic tanks.

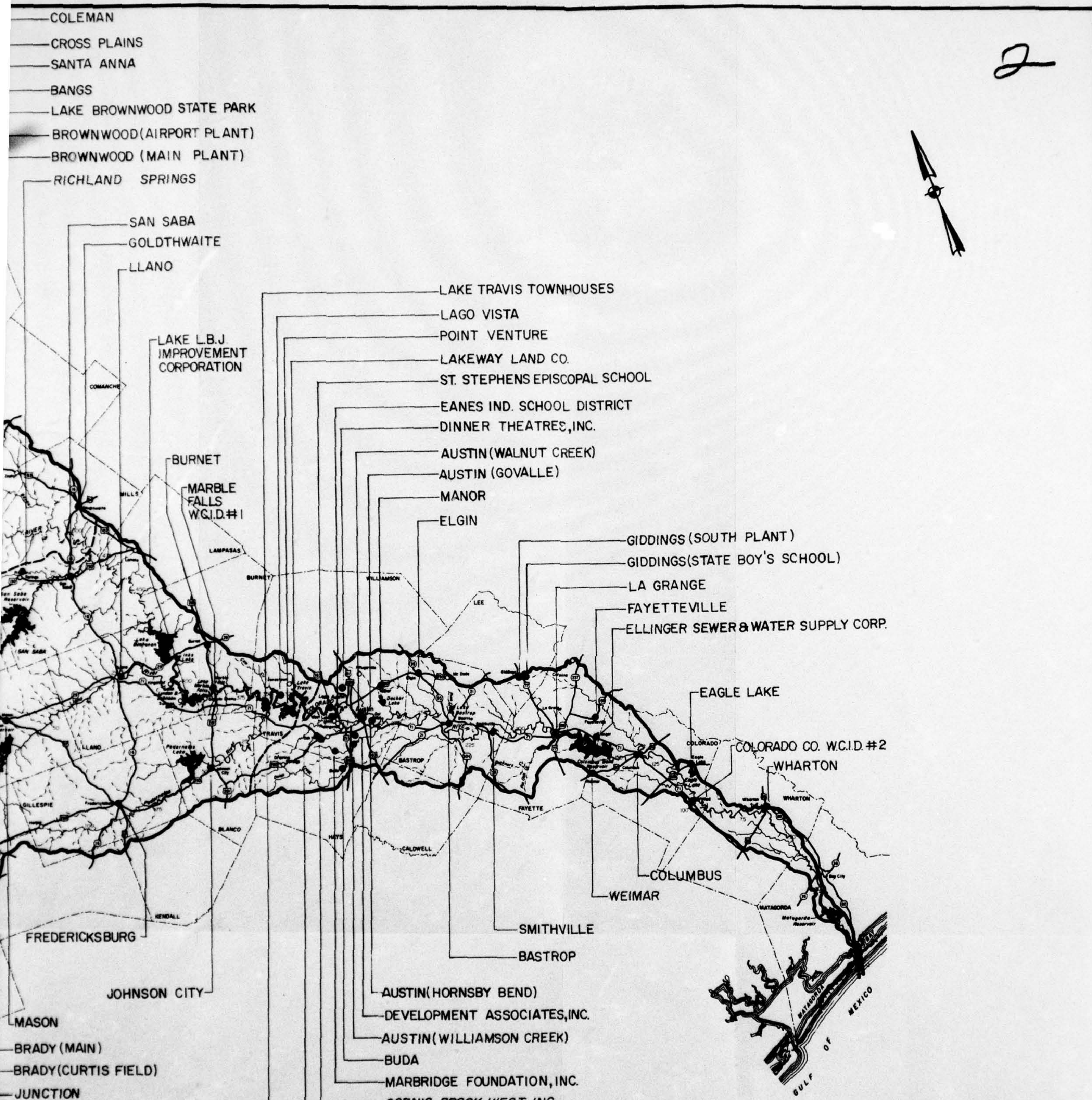
The treatment processes currently used in the Basin can be grouped under six primary classifications (see Table V-1). These range from the very basic treatment scheme involving stabilization ponds to the activated sludge process. Most of these schemes, if operated properly, are capable of providing "secondary" treatment of the influent to the plant. The basic treatment scheme of each of the six primary classifications are shown schematically on Plate V-2. These schematics are very basic and have been modified, where possible, to exemplify actual conditions in the Basin. The detailed treatment scheme of each facility is outlined in the inventory, Table V-2.

The general condition of the wastewater treatment facilities is summarized in Table V-3. As seen in Table V-3, most of the facilities visited were in good condition. In fact, only six of the plants were in poor condition. Of the six, only one is discharging daily.



PLAINS
DENVER CITY (NORTH PLANT)
DENVER CITY (SOUTH PLANT)
SUNDOWN
SEAGRAVES
BROWNFIELD
MEADOW
LAMESA
SNYDER
COLORADO CITY
LORAINE
ROBERT LEE
BRONTE
WINTERS
BALLINGER
CLYDE
SEMINOLE
ANDREWS
ODESSA
MIDLAND AIRPORT
MIDLAND
STANTON
BIG SPRING
COAHOMA
BIG LAKE
SAN ANGELO CENTER
SAN ANGELO (IRRIGATION FARM)
SAN ANGELO (CONCHO AIRFIELD)
ELDORADO
MILES
NEW MEXICO
COCHRAN
HOCKLEY
LYNN
TERRY
YOAKUM
GAINES
DAWSON
GARZA
BORDEN
SCURRY
NOLAN
TAYLOR
CALLAHAN
EASTLAND
BROWN
COLEMAN
RUNNELS
COKE
MITCHELL
HOWARD
MARTIN
ANDREWS
GLASSCOCK
STERLING
MIDLAND
ECTOR
WINKLER
CRANE
UPTON
REAGAN
IRION
TOM GREEN
CONCHO
MC CULLOCH
MENARD
MASON
SCHLEICHER
SUTTON
KIMBLE
KERR
EDWARDS
REAL
LEGEND
MUNICIPAL WASTEWATER TREATMENT FACILITIES

2



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

PERMITTED
MUNICIPAL WASTEWATER
TREATMENT FACILITIES

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 28 MI. | PLATE V - 1

TABLE V - 1

CLASSIFICATION OF MUNICIPAL WASTEWATER

TREATMENT FACILITIES IN THE COLORADO RIVER BASIN[1]

Process	Number of Facilities	Percent Utilization
Stabilization Ponds	6	6.9
Imhoff Tank + Stabalization Pond(s)	26	30.0
Imhoff Tank + Trickling Filter	5	5.7
Trickling Filter	12	13.8
Hays Contact Aeration	3	3.4
Activated Sludge & Modifications	32	36.8
Oxidation ditch (3)		
Package plants (18)		
Fixed plants (11)		
Miscellaneous	3	3.4
Total	87	

[1]*Source: Table V - 2.*

Of the plants visited, only nine were hydraulically overloaded. Another nine of the plants were out of compliance with one or more of the permitted TWQB effluent quality criteria. Only two plants were both hydraulically overloaded and out of compliance with respect to their permitted effluent quality criteria.

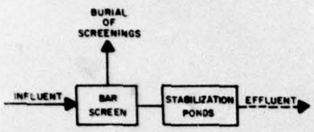
The lack of readily-available water supplies has resulted in extensive reuse of the effluent throughout the Basin, particularly in the upper and central portions of the Basin. In fact, the effluent from 41 plants is used exclusively for irrigation. The effluent from yet another nine is partially used for irrigation. Areas irrigated range from farm and pastureland to parks and golf courses. The largest single such site in the Basin is a 673-acre tract, which is owned and operated by the City of San Angelo--irrigated with the effluent from the San Angelo main treatment plant.

Reuse is not limited to irrigation, as witnessed in Odessa and Big Spring. El Paso Products, a petroleum refinery, currently purchases virtually all the effluent (an average of 6.25 mgd) from the Odessa wastewater treatment plant for 15¢/1,000 gallons. The company then spends an additional 57¢/1,000 gallons to treat the effluent such that it can be used within the refinery. Cosden Refinery, likewise, buys the effluent from the small Big Spring Hays Plant. The periodic high chloride concentrations in the return flows to the large main plant prohibit the reuse of all effluent from the Big Spring facilities by the refinery.

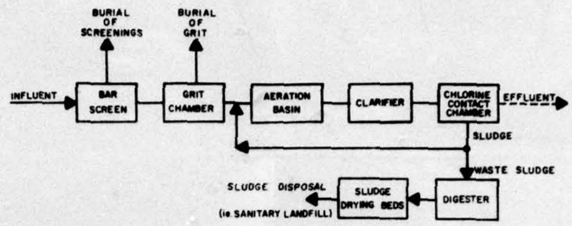
Considering the above statistics and the fact that the effluent from five plants is disposed of by evaporation, only 30 treatment facilities discharge daily to a receiving water course. Seventeen of the discharges are to the Colorado River or its immediate tributaries below Longhorn Dam. Of these, eight are discharged directly to the Colorado River.

One of the more prominent movements in wastewater treatment, regionalization, has not made significant inroads in the Basin to date due to the vast distances between facilities. Some regionalization has occurred in the Austin area, and the trend there will probably increase. Further, the City of Brownwood currently treats the sewage from the City of Early. There are still several small towns which, due to existing topography, maintain two plants--one on each side of the divide. Except possibly in metropolitan areas, the return flows are too small and the distances between communities too great to permit any significant regionalization.

STABILIZATION PONDS



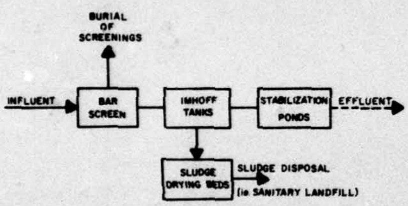
CONVENTIONAL ACTIVATED SLUDGE



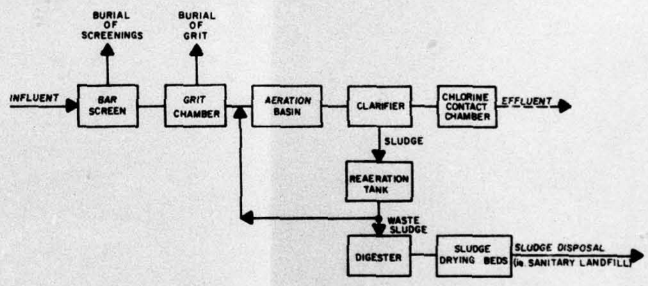
TRI

INFLUEN

IMHOFF TANK & STABILIZATION PONDS



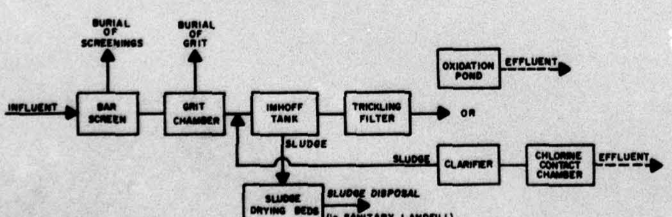
CONTACT STABILIZATION



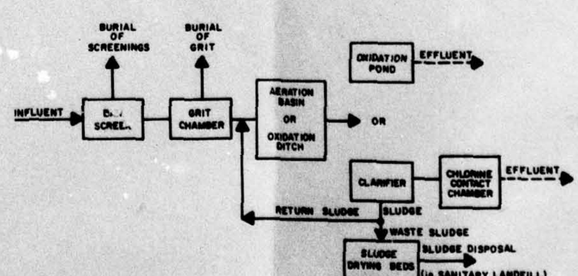
HAY

INFLUEN

IMHOFF TANK & TRICKLING FILTER

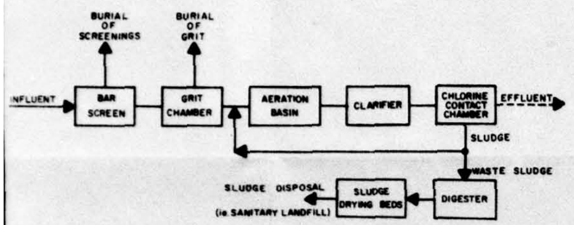


EXTENDED AERATION

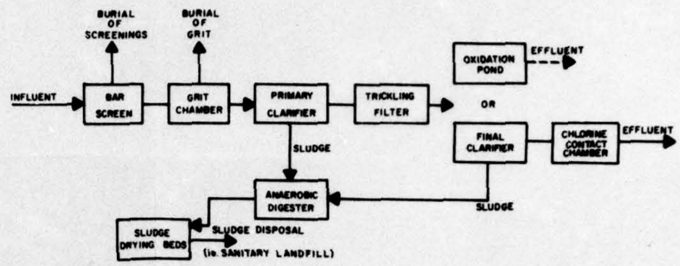


2

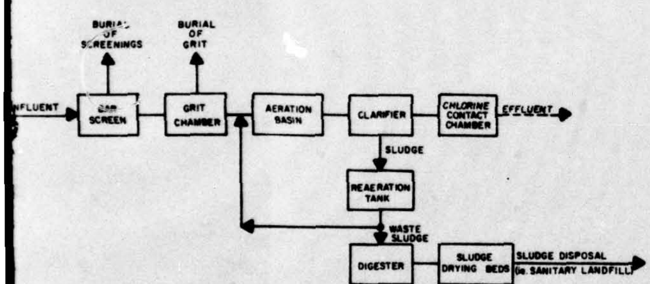
CONVENTIONAL ACTIVATED SLUDGE



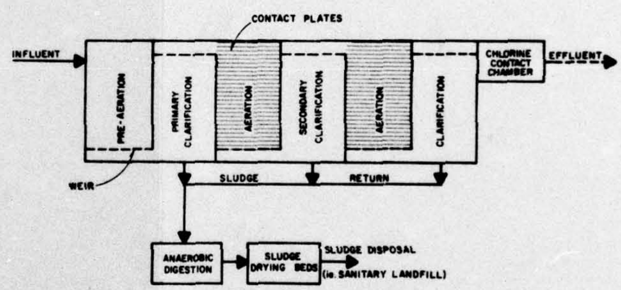
TRICKLING FILTER



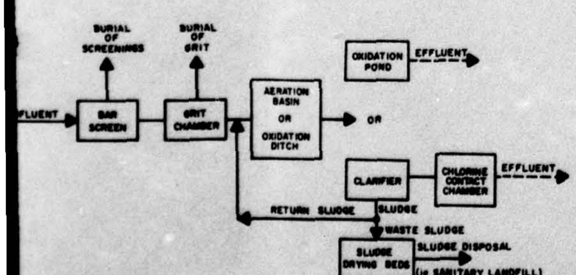
CONTACT STABILIZATION



HAYS PROCESS OR SUBMERGED CONTACT AERATION



EXTENDED AERATION



U.S. ARMY ENGINEER DISTRICT, FORT WORTH CORPS OF ENGINEERS FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY COLORADO RIVER & TRIBUTARIES, TEXAS
TYPICAL MUNICIPAL WASTEWATER TREATMENT FACILITY SCHEMES
TURNER COLLIE AND BRADEN, INC. - HOUSTON / PORT ARTHUR
SCALE: NONE   PLATE: V-2

CODES USED IN INVENTORIES

General

BOD	Biochemical Oxygen Demand	n.d.	No Discharge[1]
COD	Chemical Oxygen Demand	n.s.	None Specified
CR	Certificate of Registration (number begins with "2")	n.v.	Not Visited
		O&M	Operation and Maintenance
E	East	S	South
FM	Farm or Ranch to Market Road	TSS	Total Suspended Solids
N	North	W	West
n.a.	Not Available	WCO	Waste Control Order
n.n.d.	Normally No Discharge		

Treatment Scheme

AB	Aeration Basin	IT	Imhoff Tank
AD	Aerobic Digestor	JB	Junction Box
AnD	Anaerobic Digestor	LS	Lift Station
AeL	Aerated Lagoon	MC	Mixing Chamber
AS	Activated Sludge	OD	Oxidation Ditch (Race Track)
B	Bar Screen	OP	Oxidation Pond
C	Clarifier	PAU	Pre-Aeration Unit
CL	Clarigester	PC	Primary Clarifier
Cl	Chlorination	PP	Package Plant
CM	Comminutor	RP	Retention Pond
CS	Contact Stabilization	RT	Reaeration Tank
CT	Contact Tank	SB	Settling Basin
Ct	Chemical Treatment	SD	Sludge Digestor
DuB	Dunbar Bed	SDB	Sludge Drying Beds
EA	Extended Aeration	SP	Stabilization Pond
FC	Final Clarifier	SSP	Sludge Stabilization Pond
FM (&R)	Flow Meter (& Recorder)	SeT	Septic Tank
GC	Grit Chamber	ST	Sludge Thickener
IF	Irrigation Facilities	TF	Trickling Filter

Note: Where multiple units occur, the number is indicated in parentheses, i.e., three aeration basins, AB (3).

Operation and Maintenance (O&M)

Ex	Excellent	G	Good
F	Fair	P	Poor

Units

MGD	Million Gallons Per Day	mg/l	Milligrams Per Liter

[1] *No discharge to any waters of the state.*

Note: All permit and present effluent quantity and quality values are monthly averages unless otherwise noted.

TABLE V-2
INVENTORY OF MUNICIPAL WASTEWATER TREATMENT FACILITIES[1] IN THE COLORADO RIVER BASIN

Name	WCO Number	Location	Estimated Population Served	Treatment Scheme	O & M	Average Flow (MGD) Design	Average Flow (MGD) Present	Average Flow (MGD) Permit	Effluent Quality (mg/l) BOD Permit	BOD Present	TSS Permit	TSS Present	Comments
ANDREWS, CITY OF	10110	Andrews Co.—SE quarter of Andrews, E of S.E. McKinney St. and N of S.E. Ellis Ave. •• No discharge.	8,800	BS, LS, OD, C, SDB, RP, FM, IF	Ex	1.2	0.8	1.2[2]	20	n.a.	20	n.a.	All effluent retained with a portion used to irrigate the municipal golf course.
AUSTIN, CITY OF (Govalle)	10543-03	Travis Co.—S of the intersection of Bolm Road and Howard Lane on the N bank of the Colorado River, approx. ½ mile E of the U.S. Hwy. 183 bridge. •• Discharges into the Colorado River (approx. RM 288).	215,000	Utilizes basically two processes: (a) AS with Primary, Clarification & Aerobic Sludge Digestion, Cl. (b) CS with Aerobic Sludge Digestion, Cl.	Ex	40	26	40	20	11	20	13	
(Hornsby Bend)	10543-04	Travis Co.—N bank of the Colorado River, opposite the mouth of Carson Creek, and about one mile W of FM 973 (Platt Lane). •• Discharges into the Colorado River (at RM 283).	10,000	MC, SSP, AB	Ex	6.0	n.a.[3]	6.0	20	n.a.	–	n.a.	Sludge from the Austin treatment plants is treated at this facility.
(Williamson Creek)	10543-10	Travis Co.—S of the city at confluence of Onion & Williamson Creeks – bounded by two creeks and Nuckles Crossing Road. Any discharge enters Williamson Creek adjacent to the plant site. •• No discharge.	13,000	LS, BS, CM, FM, ST, AB (3), OP (6)	Ex	3.0	1.3[3]	2.2	20	n.a.	20	n.a.	
(Walnut Creek)	10543-11	Travis Co.—E of Austin, S of the intersection of FM 969 & Johnny Morris Road, on the E bank of Walnut Creek. •• Effluent from the facility enters Walnut Creek adjacent to the plant site.	14,000	FM, CM, BS, AB (2), OP (2)	Ex	2.5	1.4	2.5	20	n.a.	20	n.a.	Plans for 18 MGD activated sludge tertiary treatment facility on this site.
BALLINGER, CITY OF	10325-01	Runnels Co.—SE of city, on the W bank of Elm Creek approx. 800' upstream from the Colorado River.	4,000	LS, BS, GC, IT, SDB, TF, OP	F	0.28	0.22	0.28	20	44	125	70	Plans for renovation of plant to produce an effluent of acceptable quality.
BANGS, CITY OF	10122	Brown Co.—S of Bangs approx. 1.7 miles S of Atchison & Santa Fe Railway and about 0.2 miles SE of the bend in FM 586 directly S of the city. •• Discharge flows into a tributary of West Fork of Clear Creek adjacent to the plant, then into Clear Creek.	1,400	BS, IT, DUB	F	0.048	.08	.048	20	34	20	41	Plans for construction of new oxidation ditch with capacity of 0.191 MGD.

[1] See legend preceding inventory for explanation of abbreviations.

[2] No discharge permit. Both quantity and quality permitted values refer to the effluent leaving the physical treatment facility and being discharged to retention and/or irrigation facilities.

[3] Discharge is permitted; however, currently there is no discharge from the facility.

TABLE V - 2 (Cont'd.)

Name	WCO Number	Location	Estimated Population Served	Treatment Scheme	O & M	Average Flow (MGD) Design	Average Flow (MGD) Present	Average Flow (MGD) Permit	Effluent Quality (mg/l) BOD Permit	Effluent Quality (mg/l) BOD Present	Effluent Quality (mg/l) TSS Permit	Effluent Quality (mg/l) TSS Present	Comments
BASTROP, CITY OF	11076	Bastrop Co.—approx. 0.2 miles S of State Hwy. 71 in Bastrop, and immediately E of the Colorado River at Jasper & Water Streets. The effluent from the facility is discharged to the Colorado River at a point approx. 0.2 miles south of the State Hwy. 71 bridge over the Colorado River (approx. at RM 238).	3,200	BS, GC, FM, PC, AB (2), FC, CI, SDB	F	0.245	0.3	0.65	20	n.a.	20	n.a.	The facility was recently renovated and representative quality data is not available. Even with this renovation, the plant is still overloaded. The city has plans to construct a new facility with a capacity of 0.65 MGD, utilizing the activated sludge process.
BIG LAKE, CITY OF	10038	Reagan Co.—On E side of city of Big Lake, near the intersection of Alabama Avenue and Santa Ritz Street on First Street at a point approx. 1900' due E of Florida Street. •• Discharges into ditch adjacent to plant → Big Lake.	2,500	BS, IT, SP, SDB	F	0.375	0.15	0.2538	20	n.a.	152	n.a.	Effluent used for some irrigation.
BIG SPRING, CITY OF (2 plants at same location)	10089	Howard Co.—On E side of the city of Big Spring, at a point 0.6 mile SSE of the intersection of IH 20 and FM Road 700. •• Discharge at drainage ditch adjacent to Plant A → Beals Creek → Colorado River. Plant B—No discharge.	34,000	Plant A: BS, FM, PC, TF (2), FC, ST, AnD, CI	F	2.80	2.35	2.80	20	21	20	22	
			2,700	Plant B: Hays Process Plant	P	1.00	0.50[3]	1.00	20	n.a.	20	n.a.	Effluent reused by refinery (Plant B).
BRADY, CITY OF (Main Plant)	10132-01	McCulloch Co.—E of Brady, on W bank of Brady Creek, approx. 1.1 mile SE of the Courthouse. •• Effluent discharged into Brady Creek at a point approx. 0.6 miles downstream from the Gulf, Colorado & Santa Fe R.R. bridge over Brady Creek → San Saba River.	6,000	BS, GC, FM, PC, TF (2), FC, CI, SD, SDB	Ex	1.0	0.50	1.0	20	11	20	9	Portion of effluent used for irrigation.
(Curtis Field Plant)	10132-02	McCulloch Co.—approx. ¼ mile W of U.S. Hwy. 377, approx. 2½ miles N of Brady. •• No discharge to any waters in the state is permitted.	100	IT, SDB, SP	n.v.	0.015	n.a.	0.014[2]	20	n.a.	20	n.a.	
BRONTE, CITY OF	10390-01	Coke Co.—At SE corner of Bronte, on the S side of SH 158 at a point approx. 2,500 ft. due E from the Santa Fe Railway. •• No discharge.	900	BS, FM, IT, SDB, SP (2), RP	F	0.15	0.056	0.15[2]	20	n.a.	–	–	All of the effluent is used to irrigate adjacent pasture land.
BROWNFIELD, CITY OF	10677	Terry Co.—Approx. 3,750 ft. S and 1,800 ft. E of the intersection of U.S. Hwy. 62 and Second Street in the city of Brownfield. •• No discharge.	9,700	BS, GC, IT, SDB, SP	F	1.05	0.466	0.70[2]	20	–	112	–	Effluent used for irrigation.
BROWNWOOD, CITY OF (Main Plant)	10568-01	Brown Co.—At SE end of Hoover Ave. and on the N bank of Willis Creek in the E part of the city at a point 0.9 mile E of the intersection of FM Road 2524 (Austin Ave.) and Roanoke Ave. •• Discharge into Willis Creek → Pecan Bayou.	17,000	BS, GC, PC, TF (2), FC, SDB, AnD, CI	P	2.0	2.2	4.00	20	22	20	5.0	Proposed modifications should increase plant capacity to current permit value.

TABLE V-2 (Cont'd.)

Name	WCO Number	Location	Estimated Population Served	Treatment Scheme	O & M	Average Flow (MGD) Design	Average Flow (MGD) Present	Average Flow (MGD) Permit	Effluent Quality (mg/l) BOD Permit	Effluent Quality (mg/l) BOD Present	Effluent Quality (mg/l) TSS Permit	Effluent Quality (mg/l) TSS Present	Comments
BROWNWOOD, CITY OF (Airport Plant)	10868-02	Brown Co.—Approx. 6 miles N of Brownwood at a point NW of the N-S runway and on the bank of Salt Creek. •• Any discharge is into Salt Creek – Pecan Bayou.	n.a.	2 Sec, TF	G	0.15	n.a.	0.005	20	n.a.	20	n.a.	
BUDA, CITY OF	11080	Hays Co.—On the E bank of Onion Creek, at a point W of the Missouri Pacific R.R., and approx. ½ mile north of the city. •• Any discharge will enter Onion Creek at a point approx. 0.6 miles upstream from the M.P. R.R. bridge over said creek.	300	BS & GC, IT, SDB, FM, SP (3), CI	G	0.07	n.a.[3]	0.07	20	n.a.	20	n.a.	All of the effluent is used for irrigation or stored in abandoned gravel pits.
BURNET, CITY OF	10793-02	Burnet Co.—On the E bank of Hamilton Creek, approx. 3,200 ft. downstream from the Southern Pacific R.R. bridge over said creek, S of Burnet. •• Any discharge would be into Hamilton Creek adjacent to the plant.	2,500	CM & BS, FM w/R, CS w/C & CI, SDB, OP (4)	G	0.475	n.a.[3]	0.475	20	n.a.	20	n.a.	The effluent is used for irrigation.
BURNET BUCKNER BAPTIST BOYS RANCH	no permit	Burnet Co. – S of Burnet, on the N side of Lake Lyndon B. Johnson. •• Discharges into Barns Slough – Lake Lyndon B. Johnson.	85	Hays, BS, SD, SDB	n.v.	0.035	0.0085	–	–	–	–	–	The bed of the creek is decomposed granite, and effluent is adsorbed into the creek in a distance of approx. 50'.
CLYDE, CITY OF	10149	Callahan Co.—On the SE bank of Kaiser Creek, at a point approx. 0.8 miles SE of the intersection of FM 18 and FM 2700 in Callahan Co. •• Effluent discharged into said creek downstream from Lake Clyde – North Prong of Pecan Bayou – Pecan Bayou.	1,850	BS, CM, PC, AnD, SDB, SP (2)	G	0.32	0.15	0.32	20	n.a.	20	n.a.	
COAHOMA, CITY OF	10723	Howard Co.—Immediately west of FM 820, at a point approx. 1.2 miles south of the intersection of IH 20 and FM 820 in Coahoma. •• No discharge is permitted into or adjacent to any waters in the state.	1,400	SP (3)	G	0.0888	0.081	0.0888[2]	35	n.a.	–	–	All effluent is retained and used to irrigate the city cemetery and adjacent farmland.
COLEMAN, CITY OF	10150-01	Coleman Co.—E of the city on the S side of Hords Creek and N of U.S. Hwy. 84 adjacent to the intersection of Walnut and Guadalupe Streets in the city of Coleman. •• Periodic discharges into Hords Creek – Jim Ned Creek – Pecan Bayou	6,000	BS, GC, IT (2), SDB, SP (3)	P	0.26	.325	0.539	20	n.a.	20	n.a.	A new 0.8 MGD plant featuring an oxidation ditch is currently under construction. Upon completion total reuse of the effluent will be practiced. Currently a portion of the effluent is used for irrigation.
COLORADO CITY, CITY OF	10077	Mitchell Co.—In the SE corner of Colorado City at a point 2 blocks E of State Hwy. 163 at intersection of E. Central Ave. and Washington St. •• No discharge.	5,000	PC, TF, FC, AD, SDB	G	0.51	0.35	0.35[2]	35	n.a.	–	–	Effluent used for irrigation.

TABLE V - 2 (Cont'd.)

Name	WDO Number	Location	Estimated Population Served	Treatment Scheme	O & M	Average Flow (MGD) Design	Average Flow (MGD) Present	Average Flow (MGD) Permit	Effluent Quality (mg/l) BOD Permit	BOD Present	TSS Permit	TSS Present	Comments
COLORADO CO. WCBID No. 2 (Garwood)	10152	Colorado Co.—Near intersection of Mansfield and Wirtz Streets in the city of Garwood, at a point approx. .2 mile S of Colorado River •• Discharge into ditch adjacent to plant site, then into Colorado River (about RM 100.1).	500	LS, PC, AnD, SDB, TF, CP	G	0.054	n.a.	0.054	24	n.a.	87	n.a.	
COLUMBUS, CITY OF	10025	Colorado Co.—In the SE corner of Columbus, on the west bank of the Colorado River and near the end of McCormick St. •• The effluent is discharged into the Colorado River at a point adjacent to plant site (about RM 134.5).	3,900	CT, C, ST, RT, Cl, FM	G	0.65	0.35	0.65	20	n.a.	20	n.a.	This plant was placed on line in late 1972, and thus no comprehensive quality data is available.
COUNTRY AIR, INC.	11040	Travis Co.—approx. 1½ miles NW of the juncture of U.S. Hwy. 290 and State Hwy. 71, and on SE corner of subdivision. •• Discharge into ditch adjacent to plant → Williamson Creek → Onion Creek.	n.a.	EApp, Cl, FM	n.v.	0.015	0.003	0.015	20	5	20	16	
CROSS PLAINS, CITY OF	10434	Callahan Co.—approx. 1350' W of a point approx. 5000' S of the junction of State Hwys. 279 & 36. •• Discharges into Turkey Creek → Pecan Bayou.	1,100	BS, IT, SB, SP (3)	P	0.125	0.070	0.125	20	n.a.	20	n.a.	Portion of effluent is used for irrigation.
DENVER CITY, CITY OF (North Plant)	10087-01	Yoakum Co.—immediately W of State Hwy. 214, approx. 0.7 mile N of the intersection of State Hwy. 214 & FM 1939 •• No discharge.	2,000	BS, SP (3), RP, IF	Ex	0.275	n.a.	0.15[2]	–	–	–	–	Effluent used to irrigate farmland.
(South Plant)	10087-02	Yoakum Co.—immediately S of State Hwy. 83, and approx. 0.7 mile W of FM 2055. •• No discharge.	2,000	BS, IT, SP (3), IF	G	0.122	n.a.	0.15[2]	–	–	–	–	Effluent used to irrigate farmland.
DEVELOPMENT ASSOCIATES, INC.	11191	Travis Co.—approx. 0.6 miles SSE of the intersection of FM 812 & 973, and about 1.5 miles E of U.S. Hwy. 183. •• Discharge to South Fork of Dry Creek → Dry Creek.	n.a.	Complete mix pp, Cl, FM	n.v.	0.085	n.a.	0.085	20	n.a.	20	n.a.	
DINNER THEATERS, INC.	11226	Travis Co.—immediately E of FM 1325 at a point approx. 2.5 miles N of the junction of U.S. Hwy. 183 & FM 1325. •• No discharge.	500	Batch type EA pp, Cl	n.v.	0.002	n.a.	0.002[2]	20	n.a.	20	n.a.	Effluent used to irrigate sodded grassland.
EAGLE LAKE, CITY OF	10505	Colorado Co.—approx. 700' SE of the divergence of U.S. Hwy. 90-A Bypass & McCarty Ave. in Eagle Lake. •• Discharges into drainage ditch → Eagle Lake.	3,700	BS, FM & R, LS, PC, TF, AnD, SDB, FC, Cl	Ex	0.50	0.194	0.5	20	n.a.	20	n.a.	
EANES INDEPENDENT SCHOOL DISTRICT	11010	Travis Co.—near West Lake Hills, approx. 600' E of Camp Craft Road East, and 1200' N of Silver Hill Drive •• No discharge.	800	Complete mix EA pp, Cl, RP, IF	n.v.	0.07	n.a.[3]	0.024	30	n.a.	30	n.a.	Effluent totally retained and used to irrigate school property.

TABLE V - 2 (Cont'd.)

Name	WCO Number	Location	Estimated Population Served	Treatment Scheme	O & M	Average Flow (MGD) Design	Average Flow (MGD) Present	Average Flow (MGD) Permit	Effluent Quality (mg/l) BOD Permit	Effluent Quality (mg/l) BOD Present	Effluent Quality (mg/l) TSS Permit	Effluent Quality (mg/l) TSS Present	Comments
EDEN, CITY OF	10081	Concho Co.—approx. 2500' S of a point approx. 2200' E of the junction of U.S. Hwys. 83 & 87. •• Any discharge will be to Harden Branch → Brady Creek → San Saba River.	800	BS, IT, SDB, SP	F	0.1875	0.187[3]	0.187	33	n.a.	101	n.a.	
ELDORADO, CITY OF	10165	Schleicher Co.—Block A, which is bounded by Paseo De Vaca St., McKnight St., and Santa Fe R.R., of Christian Subdivision in Eldorado. •• No discharge.	1,400	IT, SP (2)	F	0.84	0.72[3]	0.072	20	n.a.	80	n.a.	Effluent used for irrigation.
ELGIN, CITY OF	10109	Bastrop Co.—611 Cleveland St. in Elgin, or approx. 2900' W of the intersection of U.S. Hwy. 290 & FM 1704. •• Discharges into Little Sandy Creek adjacent to the plant → Big Sandy Creek.	3,500	BS, GC, PAU (2), PC, TF, OP (5), AnD (2), SDB (2)	G	0.375	0.375	0.375	20	57	—	—	
ELLINGER SEWER & WATER SUPPLY CORP.	10045	Fayette Co.—approx. 825' NE of the intersection of State Hwy. 71 & FM 2503, and approx. 670' NW of the intersection of Bradbury & Schumacher Streets in Ellinger. •• Discharges into Ellinger Branch adjacent to the plant → Pettys Creek.	200	OD, FC, SDB, CI	F	0.045	0.025	0.045	20	n.a.	20	n.a.	
FAYETTEVILLE, CITY OF	10040	Fayette Co.—approx. 0.5 mile E of the intersection of State Hwy. 159 & FM 1291. •• Discharges into an unnamed tributary of Allen Creek adjacent to the plant → Pool Branch → Cummins Creek (which enters the Colorado River about 20 miles downstream from the plant site).	400	CS w/BS, CT, ST, RT, AD, SDB, CI, FM & R	G	0.05	0.034	0.05	20	11	20	17	
FREDERICKSBURG, CITY OF	10171	Gillespie Co.—approx. 70' E of U.S. Hwy. 290, and approx. 7000' SE of the intersection of U.S. Hwy. 290 & FM 1631. •• Discharges to Barron's Creek immediately below the 2nd oxidation pond → Pedernales River.	4,400	CM, CS pp, SDB, FM, OP (2)	Ex	1.00	0.75	1.0	20	6	20	11	
GIDDINGS, CITY OF[4] (South Plant)	10456-02	Lee Co.—immediately W of Sandy Creek, and about 2.0 miles S of the intersection of FM 2440 & U.S. Hwy. 77. •• Discharges into Sandy Creek adjacent to the plant → Rabbs Creek.	1,800	BS, IT, SDB, SP (2)	G	0.10	0.03	0.1	20	n.a.	58	n.a.	
GIDDINGS — STATE BOY'S SCHOOL	10456	Lee Co.—approx. 1 mile S of U.S. Hwy. 290 & 2 miles east of Giddings •• Discharge to unnamed creek → Cummins Creek → Colorado River.	440	Complete Mix, CI, C, SSP; AD	G	0.115	n.a.	0.115	20	n.a.	20	n.a.	Facility is new, and sufficient flow and effluent quality data is not available.

[4]*The City of Giddings has two (2) existing wastewater treatment plants; however, the North Plant discharges into the Brazos River Basin.*

TABLE V - 2 (Cont'd.)

Name	WQB Number	Location	Estimated Population Served	Treatment Scheme	O & M	Average Flow (MGD) Design	Average Flow (MGD) Present	Average Flow (MGD) Permit	Effluent Quality (mg/l) BOD Permit	Effluent Quality (mg/l) BOD Present	Effluent Quality (mg/l) TSS Permit	Effluent Quality (mg/l) TSS Present	Comments
GOLDTHWAITE, CITY OF	10480	Mills Co.—Approx. 1.5 miles SE of the City of Goldthwaite on State Hwy. 16 and approx. 0.9 mile SW from the junction of State Hwy. 16 and SH 284. •• No discharge.	1,400	GC, IT, FM, SP	G	0.15	0.20^{3}	0.15	20	n.a.	20	n.a.	There are currently plans for construction of a new plant. – Effluent currently used for irrigation.
JOHNSON CITY, CITY OF	10188-01	Blanco Co.—Near intersection of Ave. F & 1st Street, W of U.S. Hwy. 281 & 290, about 3700' NNW of the intersection of the above highway & FM 2766. •• Any discharge will be into an adjacent narrow draw which meanders approx. 0.5 miles before its junction with the Pedernales River approx. 2200' downstream of the U.S. Hwy. 281 bridge over the Pedernales (approx. RM 47.8).	700	IT, SDB, SP (2)	F	0.126	n.a.^{3}	0.04	20	–	88	–	Effluent used for irrigation during the summer.
JUNCTION, CITY OF	10189	Kimble Co.—E of the town, N of and adjacent to the confluence of the North and South Llano Rivers. •• Any discharge will be into the Llano River (about RM 110.6).	2,500	BS, IT, SDB, SP (2)	G	0.21	0.21^{3}	0.21	22	n.a.	20	n.a.	Effluent used to irrigate improved pasture throughout the year.
LAGO VISTA (Travis Co. MUD No. 1)	11224	Travis Co.—N of the 16th fairway of the golf course in the Lago Vista Subdivision. The subdivision is on the east side of Lake Travis and west of FM 1431. •• No discharge.	400	Complex mix pp, FM, CI, IF	Ex	0.07	0.003	0.05^{2}	20	n.a.	20	n.a.	Effluent is totally retained in lake on golf course and is used to irrigate said course. – Digested sludge is hauled to the City of Austin's Govalle sewage treatment plant for disposal.
LA GRANGE, CITY OF	10019-01	Fayette Co.—at 255 N. Franklin St., S of Lower Line St., E of and adjacent to the Colorado River, and about 1250' SSW of the intersection of U.S. Hwy. 77 & State Hwy. 71. •• Discharges into Colorado River approx. 2200' downstream from the State Hwy. 71 bridge over the Colorado River (about RM 175.4).	3,000	BS, GC, IT, TF, FC, SDB	G	0.288	0.26	0.288	20	16	25	30	
LAKE BROWNWOOD STATE PARK (Texas Parks & Wildlife Dept.)	11189	Brown Co.—Approx. 0.1 mile N of Park Road 15, approx. 0.3 miles east of Park Hdqrs. •• No discharge.	600	EA package plant, CI C, AD, IF	G	0.01	n.d.	0.01^{2}	20	••	20	••	Effluent used for irrigation. Another plant for the park (capacity of 0.025 MGD) is currently under construction.
LAKE LYNDON B. JOHNSON IMPROVEMENT CORP.	11217	Llano Co.—W of FM 2147, approx. 3 miles NE of the intersection of FM 2147 & State Hwy. 71. •• No discharge.	1,000	CS, CI, SDB, IF	E	0.10	0.011	0.10^{2}	20	n.a.	20	n.a.	Effluent used to irrigate company owned grassland.
LAKE TRAVIS TOWNHOUSES (Whitecliff Corp.)	11151	Travis Co.—Approx. 10.7 miles W of Bee Cave on State Hwy. 71 to junction with FM Rd. 2322; thence 4 miles NE to subdivision and located at S end of Judy Drive. •• Normally no discharge, however should any discharge occur it will be to Lake Travis.	n.a.	EA pp, CI, FM	n.v.	0.01	n.a.^{3}	0.01	20	n.a.	20	n.a.	Effluent used to irrigate parks and ranchland adjacent to subdivision.

TABLE V - 2 (Cont'd.)

Name	WCO Number	Location	Estimated Population Served	Treatment Scheme	O & M	Average Flow (MGD) Design	Average Flow (MGD) Present	Average Flow (MGD) Permit	Effluent Quality (mg/l) BOD Permit	Effluent Quality (mg/l) BOD Present	Effluent Quality (mg/l) TSS Permit	Effluent Quality (mg/l) TSS Present	Comments
LAKEWAY LAND COMPANY (Lakeway Inn & Marina)	10531	Travis Co.—on Lake Travis, approx. 2.5 miles N of Ranch Road 620, and approx. 6.5 miles N of the intersection of Ranch Road 620 and State Hwy. 71. •• No discharge.	200	CS pp, Cl, FM	Ex	0.1	0.012	0.1^2	12	n.a.	12	n.a.	Effluent used for irrigation.
(Lakeway World of Tennis)	11281	Travis Co.—near S shore of Lake Travis, approx. 2 miles NW of the intersection of Lohmann's Crossing Road with FM 620. •• No discharge.	n.a.	AS pp, Cl, FM	Ex	0.175	n.a.	0.175^2	20	n.a.	20	n.a.	Effluent used to irrigate company golf course.
LAMESA, CITY OF	10107	Dawson Co.—near the W bank of Sulphur Springs Draw SE of Lamesa, at a point approx. 1 mile SE of the intersection of State Hwy. 137 & Sulphur Springs Draw. •• Any discharge would be into Sulphur Springs Draw adjacent to the plant → Sulphur Springs Creek → Beal's Creek.	12,000	LS, CM, PC, TF, FC, AnD, SDB, FM & R, OP	G	1.84	0.6^3	1.88	20	n.a.	20	n.a.	Effluent used to irrigate city parks, golf course, and farmland.
LLANO, CITY OF	10208	Llano Co.—Near end of Luce St. in Llano and SW of the confluence of Oatman Creek and the Llano River, approx. 7200' SE of the intersection of State Hwys. 16 & 29. •• Discharges into the Llano River approx. 1.27 miles downstream from the State Hwy. 16 bridge over the Llano River (about RM 23.32).	2,800	FM & R, BS, GC, IT, SDB, SP	G	0.15	0.20	0.15	20	n.a.	20	n.a.	Effluent totally used for irrigation 9 months a year.
LORAINE, CITY OF	10430	Mitchell Co.—Approx. 2500' W of Mahon Road, and about 8150' WNW of the intersection of State Hwy. 644 and the Texas and Pacific RR. •• Discharge into unnamed creek adjacent to plant → North Fork of Champion Creek → Champion Creek Reservoir → Champion Creek.	700	BS, IT, TF, Cl, SB	F	0.08	0.04	0.25	20	27	35	11	A portion of the effluent is used for irrigation.
MANOR, CITY OF	11003	Travis Co.—about 2000' WNW of the intersection of State Hwy. 973 and Gregg Road, and on the E bank of Gilleland Creek. •• Discharges into Gilleland Creek adjacent to the plant.	500	IT, SDB, SP (3)	F	0.053	0.049	0.066	20	45	–	–	
MARBLE FALLS WC&ID No. 1 (Marble Falls)	10854	Burnett Co.—SE of the intersection of South 2nd St. & Ave. L in Marble Falls or about 2400' W of the N end of the U.S. Hwy. 281 bridge over the Colorado River (Lake Marble Falls). •• The effluent is pumped generally NE and discharges into the S side of Lake Marble Falls, approx. 200' upstream of the Marble Falls Dam (Max Starcke Dam).	2,000	BS, CL, TF, FC, SDB, Cl	G	0.24	0.08	0.24	20	17	20	29	

TABLE V-2 (Cont'd.)

Name	WCO Number	Location	Estimated Population Served	Treatment Scheme	O & M	Average Flow (MGD) Design	Average Flow (MGD) Present	Average Flow (MGD) Permit	Effluent Quality (mg/l) BOD Permit	Effluent Quality (mg/l) BOD Present	Effluent Quality (mg/l) TSS Permit	Effluent Quality (mg/l) TSS Present	Comments
MARBRIDGE FOUNDATION, INC.	11218	Travis Co.—Approx. 1400' NW of the intersection of Manchaca Road and the Bliss-Spiller Road which lies approx. five miles SW of Manchaca, Tex. •• No discharge.	n.a.	EA pp, Cl, FM, lined RP	n.v.	0.026	n.a.	0.026[2]	20	n.a.	20	n.a.	All of the effluent is retained and used for irrigation. — The excess sludge from the facility is removed by vacuum truck service.
MASON, CITY OF	10870	Mason Co.—SE of the City of Mason, approx. ¾ mile NE of the intersection of FM 1723 and U.S. Hwy. 87. •• Discharges into Commanche Creek — Llano River.	1,800	IT, SDB, SP (6), IF	G	0.141	0.144	0.135	20	n.a.	54	n.a.	Portion of effluent used for irrigation.
MEADOW, CITY OF	10346	Terry Co.—W of the Santa Fe Railroad and U.S. Hwy. 82, approx. 1.9 miles NNW of the intersection of U.S. Hwy. 82 & FM 211. •• No discharge.	600	SP (4), IF	F	0.05	0.04	0.05[2]	—	—	—	—	All of the effluent is retained and used for irrigation.
MENARD, CITY OF	10345	Menard Co.—on the S bank of the San Saba River, approx. 2700' NNW of the intersection of FM 2291 & U.S. Hwy. 83. •• Discharges into the San Saba River at a point approx. 1830' downstream from the U.S. Hwy. 83 bridge over said river (about RM 110.1).	900	IT, TF, SDB, OP (2), Cl, FM	G	0.264	0.06	0.18	20	n.a.	—	—	
MIDLAND, CITY OF (Main)	10223-01	Midland Co.—located at a point approx. 1.6 miles NE of the intersection of SH 158 (Florida Ave.) and IH 20 at the SE outskirts of Midland and approx. 0.05 mile S of Midland Draw. •• Normally no discharge; however, should discharge occur it will be to Midland Draw — Johnson Draw — Mustang Draw — Beals Creek.	59,500	CM, GC, PC, TF, SB, SDB, AnD (2), FM	,	4.7	4.30[3]	4.67	20	n.a.	20	n.a.	Majority of effluent is disposed of by irrigation or evaporation. The city is currently converting the facility to the activated sludge process and in so doing will increase the design capacity to 6.0 MGD.
(Airport)	10223-02	Midland Co.—Located approx. 10 miles W of the city, at a point 1.5 miles NE of the intersection of FM Road 1788 and IH 20 and at the S portion of the airport. •• No discharge.	n.a.	Hays Process Plant	G	1.00	0.15[3]	1.00	20	n.a.	20	n.a.	Effluent used for irrigation.
MILES, CITY OF	10138	Runnels Co.—at NE corner of the intersection of FM 1692 & Paint Rock Rd., and E of FM 1692 at a point about 2700' S of the intersection of said road with U.S. Hwy. 67. •• Discharges into Bottle Creek — Willow Creek — Concho River.	600	BS, GC, IT, SDB, SP	G	0.08	n.a.	0.08	20	n.a.	20	n.a.	The city has plans to totally reuse the effluent for irrigation in the near future.
ODESSA, CITY OF	10238	Ector Co.—S of the city, off IH 20 at a point approx. 1 mile S of the intersection of IH 20 and Grandview Ave. •• Discharge into Monahan's Draw adjacent to plant site — Johnson's Draw — Mustang Creek — Beals Creek.	78,000	BS, GC, FM w/R, PC (2), RP (2), AB, FC (3), AnD, SDB, Cl	G	6.0	6.25	5.50	20	n.a.	20	n.a.	El Paso Products uses 6.0 MGD of the effluent, with the remainder discharged to Manahan's Draw thence to the holding ponds.

TABLE V - 2 (Cont'd.)

Name	WCO Number	Location	Estimated Population Served	Treatment Scheme	O & M	Average Flow (MGD) Design	Average Flow (MGD) Present	Average Flow (MGD) Permit	Effluent Quality (mg/l) BOD Permit	Effluent Quality (mg/l) BOD Present	Effluent Quality (mg/l) TSS Permit	Effluent Quality (mg/l) TSS Present	Comments
PEDERNALES COUNTRY CLUB (Austin Briarcliff)	10892	Travis Co.—Approx. 4.0 miles NE of the intersection of State Hwy. 71 & FM 2322, and ½ mile E of FM 2322 adjacent to the Recreation Club facilities. •• Normally no discharge.	n.a.	EA pp, FM, CI, RP, IF	G	0.015	n.a.^{3}	0.015	20	n.a.	20	n.a.	Effluent used to irrigate golf course.
PLAINS, CITY OF	10114	Yoakum Co.—1.0 mile E of State Hwy. 214 and 1.5 miles N of U.S. Hwy. 380. •• Any discharge will be into Sulphur Springs Creek adjacent to the plant, then into Beals Creek.	1,100	BS, IT, SDB, SP	F	0.135	0.08^3	0.08	20	n.a.	–	–	
POINT VENTURE (Point Venture Development Co.)	11232	Travis Co.—Approx. 3 miles SW of Jonestown, Texas on FM 1431 to Lohmann Ford Crossing Road, then S to Point Venture on N side of Lake Travis. •• No discharge.	500	As plant with ABAD, C, CT, CI, RP	Ex	0.05	n.a.	0.036^2	20	n.a.	20	n.a.	Effluent used to irrigate curbed areas and golf course.
RICHLAND SPRINGS, CITY OF	10865	San Saba Co.—N bank of Richland Creek, E of county road, approx. 3200' N of the intersection of U.S. Hwy. 190 & Hooten Creek. •• Normally no discharge, but if should a discharge occur it would be into Richland Creek adjacent to the plant → San Saba River.	700	BS, GC, FM w/R, IT, SDB, SP	G	0.05	n.a.^{3}	0.05	20	n.a.	20	n.a.	Effluent normally used for irrigation.
ROBERT LEE, CITY OF	10803-02	Coke Co.—SW of the courthouse, on the E bank of the Colorado River, about 3400' SW of the intersection of State Hwys. 158 & 208. •• Any discharge would be into the Colorado River adjacent to the plant, approx. 1.75 miles upstream from the U.S. Hwy. 208 bridge over the Colorado River (about RM 714.1).	1,100	CS pp, CI	G	0.212	0.08^3	0.212	20	n.a.	20	n.a.	
SAN ANGELO, CITY OF (Irrigation Farm)	10641-03	Tom Green Co.—Six miles E of San Angelo on the banks of the Concho River, one mile N of FM Road 380, 3 miles E of U.S. Hwy. 277 & 87. •• No discharge.	80,000	BS, FM, LS (2), PC, SB, SD (2), RP (4), IF	F	5.107	4.8	5.107^2	33	••	124	••	Effluent totally retained and used for irrigation. Due to erratic operation of flow measuring device the present flow value is an estimated value.
(Concho Airfield)	10641-02	Tom Green Co.—E end of Mathis Airfield near the entrance of the South Concho River into Lake Nasworthy. •• No discharge.	200	Hays Contact Aeration plant, RP	n.v.	0.1	0.01	1.0^2	–	–	–	–	Effluent totally retained in holding pond.
SAN ANGELO CENTER (Texas State Dept. of Mental Health and Mental Retardation)	10834	Tom Green Co.—E of U.S. Hwy. 87, approx. 16 miles NW of San Angelo on U.S. Hwy. 87. •• No discharge – any overflow from the irrigation site will be to the North Concho River → Concho River.	500	BS, GC, IT, TF, LS, C, OP (2)	G	0.25	0.10^3	0.25	20	•	–	–	Effluent used for irrigation.

TABLE V - 2 (Cont'd.)

Name	WCO Number	Location	Estimated Population Served	Treatment Scheme	O & M	Average Flow (MGD) Design	Average Flow (MGD) Present	Average Flow (MGD) Permit	Effluent Quality (mg/l) BOD Permit	BOD Present	TSS Permit	TSS Present	Comments
SAN SABA, CITY OF	10887-01	San Saba Co.–between the San Saba River and U.S. Hwy. 190, approx. 8300' ENE of the intersection of U.S. Hwy. 190 & State Hwy. 16. •• No discharge.	2,800	IT, SDB, SP	F	0.126	n.d.	0.126^2	20	n.a.	20	n.a.	Effluent used to irrigate City Farm.
SANTA ANNA, CITY OF	10274-01	Coleman Co.–S of the city, on the E bank of Horse Creek, and about 1.2 miles S-SW of the intersection of Hwys. 67 and 283. •• Discharges to Horse Creek → Home Creek.	1,300	BS, GC, IT, SDB, SP (3)	G	0.12	0.09	0.15	20	n.a.	20	n.a.	
ST. STEPHENS EPISCOPAL SCHOOL	11202	Travis Co.–W of Austin, on S side of Lake Austin and approx. 2.5 miles N of FM 2244. •• Any discharge will be into a small unnamed creek → Lake Austin.	200	CS pp, CI	n.v.	0.05	0.02^2	0.05	20	n.a.	–	–	
SCENIC BROOK WEST, INC. (Oak Hill)	11021	Travis Co.–Approx. 1200' W of the intersection of State Hwy. 71 and U.S. Hwy. 290. •• Normally no discharge, however should discharge occur it will be to Williamson Creek → Onion Creek.	n.a.	CS pp, CI, FM, RP	n.v.	0.07	n.a.^{3}	0.05	20	n.a.	20	n.a.	Effluent used for irrigation. Plant operated by the City of Austin.
SEAGRAVES, CITY OF	10276	Gaines Co.–E of the city, 1261' N of Hwy. 83. •• No discharge.	2,440	FM & R, OD, C, SDB, OP (5)	G	0.35	0.20	0.28^2	20	n.a.	20	n.a.	Part of effluent used for irrigation with the remainder totally retained in oxidation ponds.
SEMINOLE, CITY OF	10278	Gaines Co.–S side of U.S. Hwy. 180, about 1.5 miles E of the intersection of U.S. Hwys. 180 & 385. •• No discharge.	6,500	BS & IT (2), SDB, RP	F	0.52	0.25	0.52^2	35	n.a.	–	–	Effluent retained in Playa Lake, and used for irrigation.
SMITHVILLE, CITY OF	10286	Bastrop Co.–SW of North 2nd and Royston Streets on the E bank of Gazley Creek, between FM 2571 and MKT R.R., and adjacent to and W of the intersection of FM 2571 and St. Hwy. 95. •• Discharges into Gazley Creek, adjacent to the plant, approx. 1800' above its confluence with the Colorado River (about RM 212.1).	3,000	PC, TF (2), FC, AnD, SDB, FM & R	P	0.265	0.22	0.525	20	50	20	47	Modifications should increase plant capacity to permit value.
SNYDER, CITY OF	10066	Scurry Co.–Approx. ½ mile S of Snyder, on the W side of the Roscoe, Snyder & Pacific R.R. and approx. 1500' E of Deep Creek at a point approx. .8 mile due west of FM 1685 and Avenue D in Snyder. •• Discharges into Deep Creek.	12,000	BS, GC, LS, PC, TF, FC, AnD, SDB, OP (6)	G	2.0	1.3	2.0	20	17	–	–	
STANTON, CITY OF	11043	Martin Co.–½ mile E of Hwy. 137 and ½ mile S of the city. •• No discharge.	2,200	LS, BS, GC, IT, SDB, SP (6)	F	0.2	n.d.	0.2^2	20	n.a.	–	–	Effluent used to irrigate grassland.
SUNDOWN, CITY OF	11253	Hockley Co.–Approx. 1 mi. NW of intersection of FM 301 and FM 303. •• No discharge.	1,100	SP (2), SP3, IF	G	0.14	n.d.	–^{2}	–	–	–	–	Effluent used for irrigation.

TABLE V - 2 (Cont'd.)

Name	WCO Number	Location	Estimated Population Served	Treatment Scheme	O & M	Average Flow (MGD) Design	Average Flow (MGD) Present	Average Flow (MGD) Permit	Effluent Quality (mg/l) BOD Permit	Effluent Quality (mg/l) BOD Present	Effluent Quality (mg/l) TSS Permit	Effluent Quality (mg/l) TSS Present	Comments
WEIMAR, CITY OF	10311	Colorado Co.—Approx. 3000' N of a point about 2750' E of the intersection of FM 155 & I.H. 10. •• Discharge into an unnamed branch of Harvey's Creek → Harvey's Creek.	2,000	AeL, SP (2)	G	0.50	0.072	0.48	20	n.a.	20	n.a.	
WHARTON, CITY OF	10381	Wharton Co.—On E bank of Colorado River adjacent to the S city limit boundary of Wharton and approx. 0.6 mile S of State Hwy. 60. •• Discharges to Colorado River (about RM 65.8).	9,000	BS, GC, PC, TF, AnD, CI, FC, SDB	G	0.7	1.0	0.7	20	28	20	n.a.	
WHITEFACE, CITY OF	no permit	Cochran Co.—Due N of town at a point approx. 500' W of the Hockley-Cochran County line and approx. 600' NW of the point where State Hwy. 290 intersects the above county line. •• No discharge.	380	WW, BS, IT, SP, SDB	G	0.075	n.a.[3]	–	–	–	–	–	The effluent is totally retained.
WINTERS, CITY OF	10320	Runnels Co.—Approx. 1½ miles SE of City of Winters, S of FM 53 and approx. 3000' SW of the merging of Loop 438 and Hwy. 53. •• Normally no discharge; however, any discharge will be into Bull Creek → Elm Creek.	2,700	IT, JB, SP (2)	F	0.21	0.154[3]	0.16	55	n.a.	120	n.a.	Effluent used to irrigate city-owned grassland.

TABLE V-3

STATUS OF OPERATION AND MAINTENANCE OF MUNICIPAL WASTEWATER TREATMENT FACILITIES IN THE COLORADO RIVER BASIN[1]

Process	Status of O & M				
	Poor	Fair	Good	Excellent	Unknown
Stabilization Ponds	0	1	4	1	0
Imhoff Tank + Stabilization Ponds	3	12	10	0	1
Imhoff Tank + Trickling Filter	0	2	3	0	0
Trickling Filter	3	1	6	2	0
Hayes Contact Aeration	0	1	1	0	1
Activated Sludge & Modifications					
Oxidation ditches	0	1	1	1	0
Package plants	0		4	5	9
Fixed plants	0	1	5	5	0
Miscellaneous	0	2	1	0	0

[1]*Source: Table V-2.*

Like many other plants throughout the State, several of the municipal facilities receive and treat industrial wastes. Sometimes the industry is required to pretreat its waste prior to its discharge into the sanitary sewer system. The adoption and enforcement of an industrial waste ordinance, or some such similar document, will control industrial discharge to municipal systems. These industrial loads can, if not properly monitored and regulated, impose a significant load on the municipal treatment facility.

Sizable industrial contributions are discharged to virtually all of treatment facilities in the metropolitan areas. The City of Austin's Govalle Treatment Plant receives significant amounts of industrial wastewater.

While industrial flows do affect larger municipal facilities, their effect is usually most notable on the small treatment facility. The most common example is the poultry or meat processing plant which discharges into a small system. Several small communities in the Basin, such as Fredericksburg, Miles and Clyde, treat wastewater from local industrial activities ranging from abattoirs to plating operations. Unfortunately, very few of the towns receiving these flows keep accurate records of the volume and quality of industrial discharges to the sanitary sewer system.

Prior to review of the projected municipal wastewater sources, a few additional points regarding existing facilities are pertinent. Upon review of the data presented in Table V-1, it is readily apparent that two treatment processes dominate treatment schemes in the Basin. These two processes, the Imhoff tank followed by stabilization ponds and the activated sludge process (and modifications), range from the very simple to the sophisticated. The merits and effectiveness of the activated sludge process are documented in Volume 3 of this study. However, this effectiveness is not always achieved when Imhoff tanks and stabilization ponds are used.

In the Colorado River Basin, the process involving the Imhoff tank followed by stabilization ponds does play a very significant role in wastewater treatment for many of the smaller communities. The relatively low cost of the operation has permitted the installation of a sewage collection and treatment facility in towns where otherwise it would not have been economically feasible. Surprisingly, although many of the facilities were constructed in the '50's, many were found generally to be in good operating condition. While it is true that the process does not generally result in as significant a reduction in desired constituents, the reduction obtained is satisfactory when it is followed by land disposal of the effluent, which is the case for virtually all such facilities in the Basin. Hence, it

is emphatically noted that although "basic," the process employing the Imhoff tank followed by stabilization ponds does have a very genuine role in the abatement of water pollution in the Basin.

While it is relatively simple to determine the baseline condition on municipal wastewater treatment plants in the Basin, especially with respect to the probability of the plant as a wastewater source, this is not the case with regard to future conditions. Regionalization is not expected to increase except in a few of the metropolitan areas. Consequently, it is reasonable to assume that those communities currently operating municipal wastewater treatment facilities will continue to do so. Undoubtedly, there will be more communities which will build wastewater collection and treatment facilities in the future. However, with the exception of those communities which currently have plans to construct such facilities, it is difficult to say where and when a community will, if ever, have not only the need but also the financial capability to construct wastewater collection and treatment facilities.

Some indication as to areas where wastewater collection and treatment facilities will be required in the future is given in Table II-3. Population projections were developed for any community which currently has a wastewater system, or conceivably would need a system during the duration of the study period. The absence of a community in the list does not preclude its possible need for such facilities in the future. This is particularly true in the case of developments adjacent to the freshwater lakes in the Basin.

Using Table II-3 as a guide, respective return flows and biological loading projections were developed by the Texas Water Quality Board. Results of the analysis are shown in Table V-4. A discussion of the methodology used in this analysis is presented in the Basin Plan Appendixes (Volume 2).

Summing the values presented in Table V-4, approximately 72.9 mgd of sewage could conceivably be treated by facilities within the Basin by 1980. The projections show that this amount will be more than doubled by 2020.

The pollution potential of such large volumes of sewage is obvious. Obviously, the next question is how and what level of treatment will be required prior to discharge. PL 92-500 provides some insight into this question. According to the provision of Section 301 of the Law, the following national effluent guidelines apply to publicly-owned treatment works which discharge into a receiving water:

TABLE V - 4

PROJECTED MUNICIPAL WASTEWATER RETURN FLOWS AND LOADS[1]

COLORADO RIVER BASIN

COUNTY	CITY	1970[2] Avg. Flow (mgd)	1970[2] BOD (lbs/day)	1970[2] SS (lbs/day)	1980 Avg. Flow (mgd)	1980 BOD (lbs/day)	1980 SS (lbs/day)	1990 Avg. Flow (mgd)	1990 BOD (lbs/day)	1990 SS (lbs/day)	2020 Avg. Flow (mgd)	2020 BOD (lbs/day)	2020 SS (lbs/day)
ANDREWS	Andrews*	.73	1,466	1,725	.75	1,590	1,844	.76	1,615	1,913	.77	1,723	2,086
BASTROP	Bastrop*	.31	529	622	.34	625	729	.39	707	865	.52	990	1,198
	Elgin*	.38	651	766	.44	785	916	.49	889	1,087	.66	1,264	1,530
	McDade	.03	51	60	.03	52	61	.03	50	62	.02	36	44
	Smithville*	.30	503	592	.35	628	733	.40	722	882	.55	1,058	1,281
BLANCO	Johnson City*	.08	130	153	.08	149	174	.09	162	198	.10	196	237
BORDEN	Gail	.02	30	36	.02	40	46	.02	47	57	.03	65	78
BROWN	Bangs*	.10	206	243	.10	220	256	.11	227	277	.11	247	299
	Blanket	.03	59	69	.03	63	74	.03	65	79	.03	70	85
	Brownwood*	1.48	2,953	3,474	1.52	3,229	3,767	1.57	3,317	4,055	1.58	3,532	4,276
	Early**	.09	186	219	.09	198	231	.10	205	251	.10	224	271
	May	.03	51	60	.03	54	63	.03	56	68	.03	61	74
	Zephyr	.02	35	41	.02	36	42	.02	38	46	.02	42	51
BURNET	Burnet*	.29	487	573	.32	576	672	.36	662	796	.49	929	1,125
	Granite Shoals	.03	58	68	.03	59	69	.03	59	73	.03	61	74
	Marble Falls*	.22	376	442	.23	407	475	.23	414	506	.22	426	515
CALLAHAN	Clyde*	.14	278	327	.14	302	353	.15	310	378	.15	329	398
	Cross Plains*	.10	203	238	.10	220	256	.11	225	275	.11	239	290
COCHRAN	Whiteface*	.03	67	79	.03	63	74	.03	58	70	.02	40	48
COKE	Bronte*	.08	157	185	.07	144	168	.06	128	156	.04	82	99
	Robert Lee*	.10	190	224	.08	178	208	.08	160	196	.05	112	136
COLEMAN	Coleman*	.48	953	1,122	.39	821	958	.31	664	812	.16	361	437
	Santa Anna*	.11	223	262	.10	203	237	.08	171	209	.05	106	129
COLORADO	Columbus*	.33	568	668	.35	637	743	.37	661	807	.38	718	869
	Eagle Lake*	.36	610	717	.38	684	798	.40	713	871	.41	781	945
	Garwood*	.10	163	192	.08	153	178	.08	144	176	.06	114	138
	Weimar*	.21	358	421	.19	342	399	.18	324	396	.13	255	308

[1] Does not include industrial contribution to municipal systems.

[2] 1970 values are approximations.

*Has existing wastewater collection and treatment facilities.

**City of Early's sewage is treated by the City of Brownwood.

TABLE V - 4 (Cont'd.)

COUNTY	CITY	1970 Avg. Flow (mgd)	1970 BOD (lbs/day)	1970 SS (lbs/day)	1980 Avg. Flow (mgd)	1980 BOD (lbs/day)	1980 SS (lbs/day)	1990 Avg. Flow (mgd)	1990 BOD (lbs/day)	1990 SS (lbs/day)	2020 Avg. Flow (mgd)	2020 BOD (lbs/day)	2020 SS (lbs/day)
CONCHO	Eden*	.11	219	268	.09	191	223	.07	153	187	.03	78	94
DAWSON	Ackerly	.03	59	70	.03	56	66	.02	50	62	.02	38	46
	Lamesa*	.98	1,965	2,312	.93	1,964	2,291	.87	1,849	2,259	.67	1,509	1,826
ECTOR	Goldsmith	.03	66	77	.03	67	78	.03	68	84	.03	76	92
	Odessa*	6.66	13,325	15,677	7.78	16,472	19,217	8.94	18,943	23,153	12.69	28,376	34,350
EDWARDS	Rocksprings	.10	208	244	.11	234	273	.12	252	308	.10	247	299
FAYETTE	Carmine	.05	87	102	.04	74	86	.03	61	75	.02	30	37
	Ellinger*	.02	34	40	.02	29	34	.01	23	29	.01	11	14
	Fayetteville*	.04	68	80	.03	59	69	.03	49	59	.01	25	30
	LaGrange*	.31	526	618	.31	563	657	.30	547	669	.26	492	596
GAINES	Loop	.03	54	63	.03	54	63	.02	52	64	.02	46	55
	Seagraves*	.21	415	488	.19	410	479	.19	405	495	.16	353	428
	Seminole*	.43	851	1,001	.44	923	1,077	.44	941	1,151	.43	965	1,168
GILLESPIE	Fredericksburg*	.45	905	1,065	.55	1,170	1,365	.62	1,310	1,602	.81	1,813	2,194
	Harper	.03	65	77	.03	61	71	.03	58	70	.02	46	55
GLASSCOCK	Garden Ciry	.02	49	57	.03	59	69	.03	72	88	.05	114	138
HAYS	Buda*	.05	85	100	.06	99	116	.06	110	134	.07	137	166
	Dripping Springs	.05	84	99	.06	99	116	.06	110	134	.07	137	166
HOCKLEY	Sundown*	.10	192	226	.08	178	208	.08	169	207	.06	144	175
HOWARD	Big Spring*	2.44	4,885	5,747	2.72	5,769	6,730	2.94	6,241	7,627	3.47	7,769	9,405
	Coahoma*	.10	197	232	.09	196	229	.10	205	251	.10	228	276
	Forsan	.02	40	47	.02	40	46	.02	41	51	.02	46	55
	Sand Springs	.08	154	181	.07	151	176	.07	157	191	.08	175	212
IRION	Mertzon	.04	87	103	.04	88	103	.04	88	108	.03	76	92
KIMBLE	Junction*	.23	452	532	.23	486	567	.23	495	605	.22	500	605
LAMPASAS	Lometa	.05	108	127	.05	104	122	.05	101	123	.04	86	104
LEE	Giddings	.21	355	418	.22	405	472	.23	419	513	.22	414	501
LLANO	Kingsland	.13	214	252	.14	252	294	.16	284	348	.20	390	472
	Llano*	.26	443	522	.30	533	622	.34	605	739	.45	859	1,040
	Sunrise Beach	.08	136	160	.09	157	183	.10	176	216	.13	241	292
McCULLOCH	Brady*	.47	945	1,111	.44	923	1,077	.39	828	1,012	.26	578	699
	Melvin	.02	49	58	.02	41	48	.02	32	40	.01	15	18
MARTIN	Stanton*	.18	360	423	.21	439	512	.22	475	581	.26	583	706

TABLE V - 4 (Cont'd.)

COUNTY	CITY	1970 Avg. Flow (mgd)	1970 BOD (lbs/day)	1970 SS (lbs/day)	1980 Avg. Flow (mgd)	1980 BOD (lbs/day)	1980 SS (lbs/day)	1990 Avg. Flow (mgd)	1990 BOD (lbs/day)	1990 SS (lbs/day)	2020 Avg. Flow (mgd)	2020 BOD (lbs/day)	2020 SS (lbs/day)
MASON	Mason*	.15	307	361	.13	275	321	.11	236	288	.07	160	193
MENARD	Menard*	.15	296	348	.14	297	346	.13	279	341	.10	215	260
MIDLAND	Midland*	5.05	10,109	11,893	5.29	11,221	13,091	5.55	11,756	14,368	5.96	13,325	16,130
MILLS	Goldthwaite*	.17	288	339	.16	286	334	.15	268	328	.11	211	255
MITCHELL	Colorado City*	.44	889	1,045	.39	833	972	.35	747	913	.23	517	626
	Loraine*	.06	119	140	.05	103	120	.04	86	106	.02	48	58
	Westbrook	.02	51	60	.02	45	52	.02	38	46	.01	21	25
NOLAN	Blackwell	.02	47	56	.02	41	48	.02	40	48	.01	32	39
REAGAN	Big Lake*	.21	423	498	.19	398	464	.17	360	440	.11	238	288
RUNNELS	Ballinger*	.36	715	841	.34	729	850	.33	693	847	.26	591	715
	Miles*	.05	107	126	.04	95	111	.03	74	90	.01	32	39
	Rowena	.04	76	89	.03	65	76	.02	50	62	.01	23	28
	Winters*	.25	494	581	.25	522	609	.24	504	616	.20	454	550
SAN SABA	Richland Springs*	.04	72	85	.03	59	69	.03	47	57	.01	23	28
	San Saba*	.26	434	511	.21	373	435	.17	299	365	.08	158	191
SCHLEICHER	Eldorado*	.12	246	289	.11	241	281	.09	193	235	.05	112	136
SCURRY	Hermleigh	.06	121	142	.06	110	128	.05	97	119	.03	68	83
	Ira	.04	79	93	.03	70	82	.03	63	77	.02	44	53
	Snyder*	.95	1,899	2,234	.90	1,913	2,232	.85	1,795	2,193	.66	1,478	1,789
STERLING	Sterling City	.07	133	156	.06	124	145	.05	112	136	.04	93	113
SUTTON	Lawn	.03	58	69	.03	58	67	.03	56	68	.02	49	60
	Tuscola	.04	84	99	.04	85	99	.04	81	99	.03	72	87
TERRY	Brownfield*	.82	1,640	1,929	.91	1,924	2,245	.97	2,054	2,510	1.09	2,440	2,953
	Meadow*	.04	83	98	.04	85	99	.04	86	106	.04	87	106
TOM GREEN	Christoval	.02	37	43	.02	40	46	.02	45	55	.02	55	67
	San Angelo*	5.42	10,860	12,776	6.29	13,329	15,550	7.28	15,419	18,845	10.56	23,608	28,578
	Sanatorium	.04	76	90	.04	81	94	.04	88	108	.05	108	131
TRAVIS	Austin*	25.18	42,807	50,362	32.69	58,838	68,645	42.99	77,386	94,582	91.21	173,301	209,785
	Del Valle	.03	51	60	.04	70	82	.05	86	106	.08	154	186
	Elroy	.01	21	25	.02	31	36	.02	38	46	.03	65	78
	Jonestown	.12	202	238	.14	248	290	.16	297	363	.20	380	460
	Lago Vista*	.01	15	18	.45	810	945	1.12	2,021	2,471	3.30	6,270	7,590
	Lakeway*	.07	124	146	.50	900	1,050	.93	1,674	2,046	2.19	4,159	5,036
	Manor*	.09	160	188	.12	212	248	.14	259	317	.24	456	552
	Oak Hill	.04	72	85	.06	101	118	.07	124	152	.15	283	343

TABLE V - 4 (Cont'd.)

COUNTY	CITY	1970 Avg. Flow (mgd)	1970 BOD (lbs/day)	1970 SS (lbs/day)	1980 Avg. Flow (mgd)	1980 BOD (lbs/day)	1980 SS (lbs/day)	1990 Avg. Flow (mgd)	1990 BOD (lbs/day)	1990 SS (lbs/day)	2020 Avg. Flow (mgd)	2020 BOD (lbs/day)	2020 SS (lbs/day)
TRAVIS (Cont'd.)	Pflugerville	.05	93	110	.07	131	153	.09	160	196	.14	260	315
	Point Venture*	.04	68	80	.20	360	420	.27	479	585	.42	798	966
	Rollingwood	.08	133	156	.10	182	212	.12	223	273	.21	391	474
	Sunset Valley	.03	50	58	.04	70	82	.05	86	106	.08	152	184
	West Lake Hills	.15	253	298	.19	344	401	.23	421	515	.39	739	895
WHARTON	Wharton	.08	134	158	.09	160	187	.09	166	202	.09	177	214
YOAKUM	Denver City	.35	703	827	.38	810	945	.39	821	1,003	.37	830	1,005
	Plains	.09	185	217	.08	171	200	.08	167	205	.07	150	182

1977 - effluent must have received at least secondary treatment.

1983 - effluent is to receive the best practicable waste treatment technology available over the life of the works.

The Law also provides for more stringent criteria where needed.

Considering the above criteria, it can be assumed that by 1977 all municipal wastewater discharge will receive at least secondary treatment. Further, it is believed that those facilities currently practicing reuse will continue to do so and that this practice will spread. Primary reasons for this projected increase in reuse is the projected need for water and the high costs associated with construction of facilities capable of producing the type of treatment required in the national effluent guidelines of 1983 and 1985.

In view of the above facts, it would seem that the effluent from most of the smaller facilities will be reused. The general topography and lack of suitable irrigable lands adjacent to several of the freshwater lakes could result in either reuse or tertiary treatment in these areas. Especially in the case of larger cities (such as Austin), reuse may not be feasible, and thus advanced treatment will be required.

Due to climatic and land availability characteristics of the Colorado River Basin, sludge handling and disposal for virtually all municipalities or entities is a relatively simple matter. Of the various available techniques for the reduction of moisture content in sludges, vacuum filtration, centrifuges, filter presses, air-drying, etc., only air-drying on sludge drying beds is within the financial and technical capabilities of the small cities in the Basin. For a majority of the Basin, the temperature and substantial evaporative potential (Section 2) provides an optimum condition for the air-drying of sludges. The availability of land also provides no constraint as might be expected in other parts of the nation.

Exceptions to this generalization may be found in Austin and in the area between Austin and the mouth of the river. In Austin, the lack of available land and the volume of sludge generated may eventually dictate some form of mechanical treatment for waste sludge. Below Austin toward the Gulf of Mexico, the amount of precipitation is such that, for a particular city, complete air-drying of sludges may be impossible or require such extensive drying beds that complete or partial mechanical dewatering would be justified by engineering study.

Industrial Wastewater Treatment Facilities.

The discussion of industrial wastewater treatment facilities, which follows, addresses only those operations which have received a waste control permit from the TWQB. All of the data regarding location, wastewater generated, and treatment scheme employed were taken from the respective waste control permit. The "present" effluent quality and quantity were taken from the TWQB Self-Reporting Data for the period of July 1971 - June 1972. This period is referred to as "the period of record." Where possible, permit and Self-Reporting Data were supplemented by data contained in the files of the TWQB.

In order to facilitiate the review of the permitted industries, they were classed under five groups. These groups are:

Livestock Operations
Sand and Gravel Operations
Thermoelectric Power Generation Operations
Heavy Industrial Operations
Commercial-Industrial Solid Waste Disposal Facilities

The so-called "solid waste disposal facilities" do in fact receive liquids and semi-liquids and, as such, are included in this discussion.

Unlike municipal return flows, there is no accepted methodology for forecasting industrial wastewater discharges. Consequently, for the purposes of this study, it has been assumed that industrial wastewater discharges within the Basin will remain relatively constant through the planning period. This assumption is based on the following:

1. A large portion of the Basin has a limited potential for heavy industrial growth due to the lack of dependable water supplies.

2. Most of the permitted industrial operations are currently not discharging and are expected not to discharge in the future.

3. Modern technology is leaning toward closed-cycle cooling systems and other improvements to reduce industrial discharge.

4. The stringent conditions placed on industrial effluent quality by the Federal Water Pollution Control Act, as amended, are expected to prohibit any significant increase in waste loads to the waters of the Colorado River Basin.

Therefore, no projected discharge volumes or attendant loads are presented in the following discussion.

Livestock Operations.

Livestock production and processing is an integral component of the economic foundation of the Basin. The industry has continued to grow such that virtually every facet of the industry is currently situated in the Basin. Coincident with this growth has been the significant pollution potential posed by the variety and concentration of organic wastes generated by the industry. The ever-increasing use of confined feeder operations, and the attendant concentration of large quantities of organic wastes and wastewater, has accentuated the potential problem and the need for appropriate protection and treatment schemes.

The discharges from the industry are regulated by the TWQB. To date, the Board has issued 56 waste control permits (Table V-5) for various livestock operations throughout the Basin (Plate V-3). As seen in the inventory, Table V-5, and summarized in Table V-6, permits have been issued for feedlots, commercial swine production operations, dairies, rendering plants, and slaughterhouses. Without exception, the facilities are issued "no discharge" permits. That is, the waste control system is to be designed such that none of the waste is discharged to any waters of the State.

The majority of these permits have been issued for commercial swine production (farrowing and finishing) operations and cattle feedlots. Of the twelve cattle feedlots in the Basin, six have a capacity of 10,000 head or more. The total capacity of the cattle feedlots is estimated at 101,800 head. Assuming that on any one day the entire capacity of the cattle feedlots is utilized, it is estimated that approximately 3,760 tons of manure would be produced with a 5-day biochemical oxygen demand of about 0.3 million pounds. The importance of proper treatment of this waste is obvious.

Swine production in the Basin consists primarily of farrowing and finishing operations. In general, the swine operations are smaller than the cattle operations, ranging in size from a capacity of 26 to 5,750 head.

TABLE V - 5

INVENTORY OF PERMITTED LIVESTOCK OPERATIONS IN THE COLORADO RIVER BASIN

(Livestock Production and Processing Operations)

NAME	WCO/CR Number[1]	TYPE OF INDUSTRY	LOCATION
ALPHA PORK PRODUCERS	20163	Commercial Swine Production (1,730 head capacity)	Brown Co. – 1/4 mile E of FM 590 at a point approx. 5 miles NE of Zephyr, and approx. 14 miles east of Brownwood •• Operation in the drainage area of Dry Blanket Creek – Big Blanket Creek – Pecan Bayou.
BACA CATTLE FEEDERS	01537	Cattle Feedlot (12,000 head capacity)	Midland Co. – immediately W of FM 1788, 3 miles NW of the intersection of FM 1788 with U.S. Hwy. 80, and approx. 3 miles W of the Midland-Odessa Regional Air Terminal •• Watershed of Monahans Draw – Midland Draw – Mustang Creek – Beals Creek.
BAR D HOG COMPANY	01467	Swine Feedlot (443 sow capacity)	Mason Co. – approx. 2 miles NE of the intersection of State Hwy. 29 and U.S. Hwy. 87, and about 1.5 miles N of State Hwy. 29 •• Facilities in drainage area of Wolf Creek – Commanche Creek – Llano River.
BEAKLEY BROS. ENTERPRISES	20063	Commercial Swine Production (1,560 head capacity)	McCulloch Co. – immediately E of a county road at a point approx. 3 miles N of FM 502, and approx. 3 miles E of U.S. Hwy. 377 •• Operation in drainage area of an unnamed creek.
BEAN-DRISKILL SWINE PRODUCERS	01457	Swine Feedlot (1,000 head capacity)	Brown Co. – 0.6 mile E of the intersection of FM 2125 with State Hwy. 279, and 0.3 mile N of the intersection of State Hwy. 279 and Walnut Street in Brownwood •• Facilities within the drainage area of Pecan Bayou.
BLUE RIBBON FEEDERS	01284	Cattle Feedlot (3,500 head capacity)	Colorado Co. – immediately W of FM 102 and 2.3 miles S of I.H. 10 •• Operation in watershed of Horseshoe Gully.
ERNEST W. BRACEWELL, SR. – SOUTHSIDE MARKET	20168	Slaughterhouse	Bastrop Co. – immediately E of FM 1704 at a point about 4 miles W of the intersection of FM 696 and U.S. Hwy. 290 •• Plant and disposal area in Little Sandy Creek watershed – Big Sandy Creek.
CAPITOL CATTLE COMPANY	01734	Cattle Transfer and Holding Facility (40,000 head capacity)	Travis Co. – immediately N of FM 812 at a point 0.7 mile E of the intersection of FM 812 and U.S. Hwy. 183 •• Facility located within Onion Creek watershed.
D & D FEEDLOT	01592-01	Cattle Feedlot (4,000 head capacity)	Lee Co. – approx. 3.5 miles S of U.S. Hwy. 290 and about 1.5 miles N of the intersection of FM 448 and 2239 •• Operation within watershed of Rabbs Creek.
	01592-02	Cattle Feedlot (1,300 head capacity)	Lee Co. – approx. 1.5 miles NNW of the intersection of FM 448 and 2239, about 3.5 miles S of U.S. Hwy. 290 •• Within Rabbs Creek watershed.
DEL VALLE HOG FARM	20289	Commercial Swine Production (650 head capacity)	Travis Co. – immediately N of a county road at a point approx. 2.5 miles SE of the intersection of FM 973 with State Hwy. 71 •• Facility in area drained by unnamed branch of Dry Creek.
GENE DOSS FEEDLOT	20249	Commercial Swine Production (600 head capacity)	Brown Co. – approx. 2 miles SE of the intersection of U.S. Hwy. 377 with FM 586, and about 11 miles SSW of the intersection of U.S. Hwy. 377 with FM 45 •• Operation within drainage area of an unnamed creek – Clear Creek.
H. W. DOYLE PROCESSING PLANT	20455	Slaughterhouse and meat packing	Lee Co. – immediately E of U.S. Hwy. 77 at a point approx. 1.1 mile SE of the intersection of said highway and U.S. Hwy. 290 •• Within the drainage area of Sandy Creek – Rabbs Creek.

[1] *WCO – Waste Control Order; CR – Certificate of Registration (number begins with "2")*

Note: Those operations which submitted Self Reporting Data for the current reporting period, July 1971 - June 1972, reported "no discharge" from their respective facility.

TABLE V - 5 (Cont'd.)

NAME	WCO/CR Number[1]	TYPE OF INDUSTRY	LOCATION
EZELL-KEY GRAIN CO., INC.	01670	Cattle Feedlot (10,000 head capacity)	Scurry Co. – between U.S. Hwy. 84 and the Roscoe, Snyder, & Pacific RR, and approx. 2 miles SE of the intersection of U.S. Hwys. 84 and 180 •• Within the watershed of an unnamed creek – Deep Creek.
FAYETTE COUNTY SWINE BREEDERS, INC.	20440	Commercial Swine Production (3,240 head capacity)	Fayette Co. – immediately N of the MK&T Railroad track at a point approx. 1/2 mile N of State Hwy. 71, and about 6 miles W of the intersection of the above highway and U.S. Hwy. 77 in La Grange •• In the drainage area of Wertzner Creek – Baylor Creek.
F & M FEED LOT	20077	Swine Feedlot (1,000 head capacity)	Mason Co. – immediately N of a county road at a point about 4 miles W of the intersection of FM 152 and 2768. •• Facility adjacent to the Llano River.
JEROME K. FELPS	20082	Commercial Swine Production (1,127 head capacity)	Burnet Co. – immediately east of a county road (Norman Miller Road) at a point 1.3 miles E of U.S. Hwy. 281 and 1.5 miles S of State Hwy. 29 •• Operation within area drained by an unnamed creek – Hamilton Creek.
DON GEESLIN FARMS	01650	Sheep Feedlot (30,000 head capacity)	Mills Co. – (1) immediately W of U.S. Hwy. 84 at a point approx. 1 mile S of the intersection of U.S. Hwy. 84 and FM 1029; (2) approx. 0.5 mile E of State Hwy. 16 at a point approx. 2.5 miles NNE of the intersection of State Hwy. 16 with U.S. Hwy. 84 •• Both facilities are within the Brown Creek watershed – Pecan Bayou.
MARVIN GOETZ	20134	Commercial Swine Production (1,200 head capacity)	Tom Green Co. – 1/4 mile S of a county road at a point 1.0 mile N of U.S. Hwy. 87, and 1/2 mile W of the Tom Green Co. line •• Operation in area drained by Snake Creek – Lipan Creek – Concho River.
CLARENCE HASSE	20313	Commercial Swine Production (1,000 head capacity)	Mason Co. – about 1/2 mile NW of the intersection of a county road and FM 152 at a point approx. 6½ miles NE of the intersection of U.S. Hwy. 87 and FM 152 •• Operation within the immediate drainage area of the Llano River.
R. M. HEFFLEY	20373	Commercial Swine Production (105 head capacity)	Colorado Co. – about 150 yards W of State Hwy. 71 at a point approx. 3 miles S of the intersection of Interstate Hwy. 10 and State Hwy. 71 •• Within Wolfpen Creek watershed.
KENNETH HOLLAS	01732	Dairy (75 head capacity)	Fayette Co. – approx. one (1) mile E of FM 155 at a point about 3.1 miles N of the city of Weimar. •• Facility within drainage area of Harvey Creek.
A. J. and A. D. HOPSON	20284	Commercial Swine Production (1,625 head capacity)	Llano Co. – immediately east of FM 2323 at a point 6.5 miles SW of the city limits of Llano •• Within area drained by an unnamed creek – Six Mile Creek – Llano River.
J. S. RANCH, INC.	20018	Commercial Swine Production (5,750 head capacity)	Colorado Co. – at the dead end of a county road, 3.5 miles SE of the intersection of FM 954 and State Hwy. 159, and approx. 16 miles N of Columbus •• Facility in the watershed of an unnamed creek – Poplar Creek – Boggy Creek – Cummins Creek.
STERLING JORDAN FEEDLOT	20480	Commercial Swine Production (600 head capacity)	Mason Co. – approx. one-fourth (1/4) mile S of State Hwy. 29, 8 miles NW of the intersection of U.S. Hwy. 87 and FM 863, and about 5 miles E of the city limits of Mason •• Feedlot in Big Willow Creek watershed – Llano River.
KOTHMANN COMMISSION CO.	01661	Sheep Feedlot (35,000 head capacity)	Menard Co. – N of State Hwy. 29, approx. 1.5 miles W of the intersection of State Hwys. 29 and 83 •• Adjacent to the San Saba River.

TABLE V - 5 (Cont'd.)

NAME	WCO/CR Number[1]	TYPE OF INDUSTRY	LOCATION
NOEL G. LAWSON	20009	Commercial Swine Production (26 head capacity)	Travis Co. – immediately W of Nuckles Crossing Road at a point approx. 0.5 mile S of East Elmo Road, and about 1.7 miles SE of the intersection of East Elmo Road and I.H. 35 •• Operation in the drainage area of unnamed creek – Williamson Creek – Onion Creek.
LIVE OAK FARM	01453	Commercial Swine Production (3,500 head capacity)	Tom Green Co. – approx. 1200' E of U.S. Hwy. 277 and immediately N of a county road that intersects the above Hwy. at a point approx. 4 miles S of Christoval •• The facility is in the watershed of an unnamed creek which flows into Cole Creek – South Concho River – Concho River.
LONG & PITTMAN	20123	Commercial Swine Production (740 head capacity)	Bastrop Co. – 1/2 mile W of State Hwy. 95 at a point immediately SE of a county road which intersects the above Hwy. approx. 1/8 mile N of the intersection of State Hwy. 95 with FM 1441 •• Operation within the area drained by an unnamed creek which flows into Piney Creek.
MARKET PRODUCE, INC.	01613	Turkey Feedlot (27,500 bird capacity)	Gillespie Co. – immediately N of a county road at a point approx. 3.5 miles SW of FM 1376, and 5 miles S of U.S. Hwy. 290 •• The facility is in the area drained by Grape Creek – Pedernales River.
MASON FEED STORE	01449	Swine and Cattle Feedlot	Mason Co. – approx. 1.25 miles SE of the intersection of State Hwy. 29 with U.S. Hwy. 377, and about 1/4 mile N of a county road •• Operation in drainage area of an unnamed creek – Honey Creek – Llano River.
MASON FEEDERS, INC.	01454	Cattle Feedlot (8,000 head capacity)	Mason Co. – approx. 1 mile SE of the intersection of State Hwy. 29 and U.S. Hwy. 377 and about 1/2 mile N of a country road •• In same watershed as Mason Feed Store.
HERBERT E. MERTZ, JR.	01591	Turkey Farm (15,000 bird capacity)	Gillespie Co. – about 1/4 mile W of a county road, and approx. 2 miles S of FM 1623 at a point approx. 2 miles SW of Albert •• The facility is in the area drained by the West Fork of Williams Creek – Williams Creek – Pedernales River.
ELAM MILES	01625	Sheep Feedlot (10,000 head capacity)	Mills Co. – immediately E of the intersection of U.S. Hwy. 84 and FM 1029 •• The operation is within Browns' Creek watershed – Pecan Bayou.
EDGAR J. MOSS	20035	Commercial Swine Production (710 head capacity)	Llano Co. – immediately S of a county road at a point 1.5 miles E of the intersection of State Hwy. 16 and FM 965 •• The industry is in the area drained by Sandy Creek – Lake Lyndon B. Johnson.
GENE NEWMAN dba VERIBEST CATTLE FEEDERS	01294	Cattle Feedlot (15,000 head capacity)	Tom Green Co. – approx. 1/2 mile N of FM 380, at a point about 1.4 miles W of the intersection of FM 380 and 2334 •• The facility is within the Concho River watershed.
LARRY F. OXLEY	20427	Commercial Swine Production (134 head capacity)	Tom Green Co. – immediately E of a county road at a point 1/2 mile N of U.S. Hwy. 87 and 3 miles E of Vancourt and about 16 miles SE of San Angelo •• Operation in Snake Creek watershed – Lipan Creek – Concho River.
CHARLES H. PLUENNEKE	20026	Commercial Swine Production (220 head capacity)	Mason Co. – immediately E of a county road at a point approx. 1 mile N of its intersection with State Hwy. 29, and approx. 2.2 miles NNE of the intersection of U.S. Hwy. 87 and FM 1723 •• Operation is in the drainage area of an unnamed branch of Wolf Creek – Commanche Creek – Llano River.
PONTOTOC SWINE BREEDERS, INC.	01472	Swine Farrowing Operation (200 sow capacity)	Mason Co. – immediately W of an unpaved county road at a point approx. 3 miles S of the intersection of State Hwy. 71 and FM 501 •• The facility is in the watershed of San Fernado Creek – Llano River.

TABLE V - 5 (Cont'd.)

NAME	WCO/CR Number[1]	TYPE OF INDUSTRY	LOCATION
SAN ANGELO BY-PRODUCTS, INC.	01594	Rendering Plant	Tom Green Co. – N of and adjacent to FM 380 at a point approx. 1.5 miles west of the intersection of FM 380 and 2334 •• The plant is in the drainage area of an unnamed creek which flows into the Concho River.
SAN ANGELO FEED YARDS, INC.	01522	Cattle Feedlot (12,000 head capacity)	Tom Green Co. – immediately N of U.S. Hwy. 67 at a point approx. 5 miles ENE of the intersection of the Hwy. with FM 1692 •• The facility is in an area drained by an unnamed branch of the Concho River.
SAM RABB	20290	Commercial Swine Production (450 head capacity)	Llano Co. – adjacent to and N of State Hwy. 71 at a point approx. 3 miles NW of the intersection of said highway and State Hwy. 29 •• Within Willow Creek watershed – Llano River.
SANSOM & SONS DAIRY[2]	01574	Dai y (300 head capacity)	Travis Co. – approx. 1/2 mile SW of FM 969 at a point approx. 7 miles ESE of the intersection of FM 969 and 973 •• The dairy is adjacent to the Colorado River.
W. L. SCHROEDER MEAT CO.	20434	Slaughterhouse and meat processing	Yoakum Co. – adjacent to FM 1544, approx. 1.0 mile N of the intersection of said road and FM 1939, and further defined as being 4 miles S of the intersection of FM 213 and 1544 •• Facility in the watershed of Sulphur Springs Draw – Sulphur Springs Creek – Beals Creek.
M. O. SCOTT	20828	Commercial Swine Production (450 head capacity)	Burnet Co. – S of and adjacent to a county road at a point approx. 5 miles NE of the intersection of State Hwy. 71 and U.S. Hwy. 281 •• The operation is within the drainage area of an unnamed creek which flows into Doublehorn Creek.
SIMPSON & SIMPSON HOG CO.	20297	Commercial Swine Production (1075 head capacity)	Llano Co. – immediately E of State Hwy. 16 at a point approx. 5 miles N of the intersection of State Hwy. 29 and FM 2241 •• The facility is in the Wrights Creek watershed – Llano River.
ELMER R. SMITH	20291	Commercial Swine Production (685 head capacity)	Llano Co. – immediately E & W of FM 2323 at a point 0.7 miles S of FM 152 and 8 miles W of State Hwy. 16 •• Operation in watershed of Bullhead Creek – Hickory Creek – Llano River. 13 miles SW of Llano City limits.
C. A. STAATS TURKEY FARM	01658	Turkey Farm (43,000 bird capacity)	Gillespie Co. – approx. 2 miles S of FM 1376 at a point approx. 4 miles SSE of the intersection of FM 1376 with U.S. Hwy. 290 •• The farm is within the drainage area of Grape Creek – Pedernales River.
STRUBE MARKET & LOCKER	20463	Slaughterhouse and meat market	Runnels Co. – immediately S of U.S. Hwy. 67 at a point approx. 3/4 mile E of its intersection with FM 2133 and further located approx. 8 miles SW of Ballinger •• Operation located in Rock Creek watershed.
TEXAS CALF PALACE, INC.	01436	Cattle Preconditioning Operation (20,000 head capacity)	Gaines Co. – approx. 3 miles E of the Texas-New Mexico state line, and 5 miles N of U.S. Hwy. 180 •• The site is in the Seminole Draw drainage area – Monument Draw – Mustang Creek – Beals Creek.
TEXAS RENDERING CO., INC.	20329	Rendering Plant	Bastrop Co. – immediately N of FM 2336 at a point approx. 0.8 mile E of the intersection of FM 2336 and State Hwy. 95 •• The plant is in the Harris Creek watershed – Big Sandy Creek.
DON WAGGONER	20252	Swine Feedlot (200 head capacity)	Tom Green Co. – S of and adjacent to FM 380 at a point approx. 3.3 miles E of the intersection of U.S. Hwy. 277 with FM 380 •• The feedlot is within an area drained by an unnamed creek which flows into the Concho River.

[2]This WCO is currently administratively inactive.

TABLE V - 5 (Cont'd.)

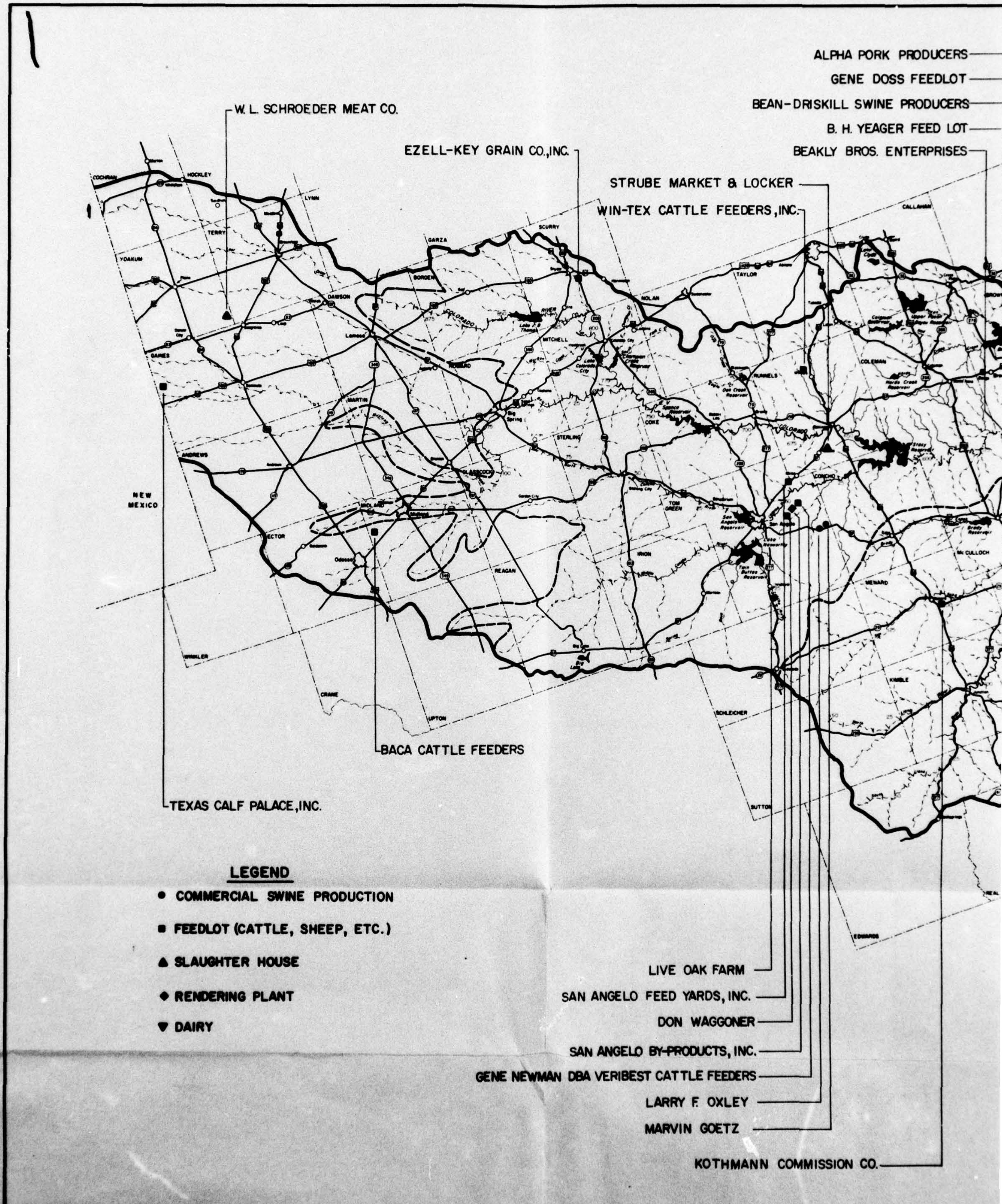
NAME	WCO/CR Number[1]	TYPE OF INDUSTRY	LOCATION
RALPH VOSS	20470	Commercial Swine Production (1500 head capacity)	Fayette Co. – about 1½ miles W of the intersection of State Hwy. 71 and FM 609, and further defined as being approx. 2½ miles W of La Grange •• Facility within Taylor Branch watershed – Buckners Creek.
WINDY HILL FARM	20351	Commercial Swine Production (1,280 head capacity)	Hays Co. – approx. 1/4 mile W of a county road at a point 2½ miles NE of the intersection of FM 165 and U.S. Hwy. 290 •• The operation is in the drainage area of an unnamed creek which flows into Barton Creek – Town Lake.
WIN-TEX CATTLE FEEDERS, INC.	01386	Cattle Feedlot (15,000 head capacity)	Runnels Co. – immediately NW of the intersection of two county roads and approx. 1.7 miles WNW of the intersection of U.S. Hwy. 83 and FM 2405 •• The feedlot is in an area drained by Big Coyote Creek – Coyote Creek – Elm Creek.
M. J. WOOTAN CUSTOM FEEDING LOT	20104	Commercial Swine Production (1,515 head capacity)	Llano Co. – immediately N of U.S. Hwy. 71 at a point about 2 miles E of its intersection with FM 2323 and approx. 1½ miles SE of the city limits of Llano•• In drainage area of Byrnes Creek – Llano River.
B. H. YEAGER FEED LOT	01672	Cattle Feedlot (1,000 head capacity)	Brown Co. – approx. 1.0 mile E of U.S. Hwy. 183 at a point approx. 2.5 miles NNE of the intersection of U.S. Hwys. 183 and 67 •• Feedlot located within Pecan Bayou watershed.

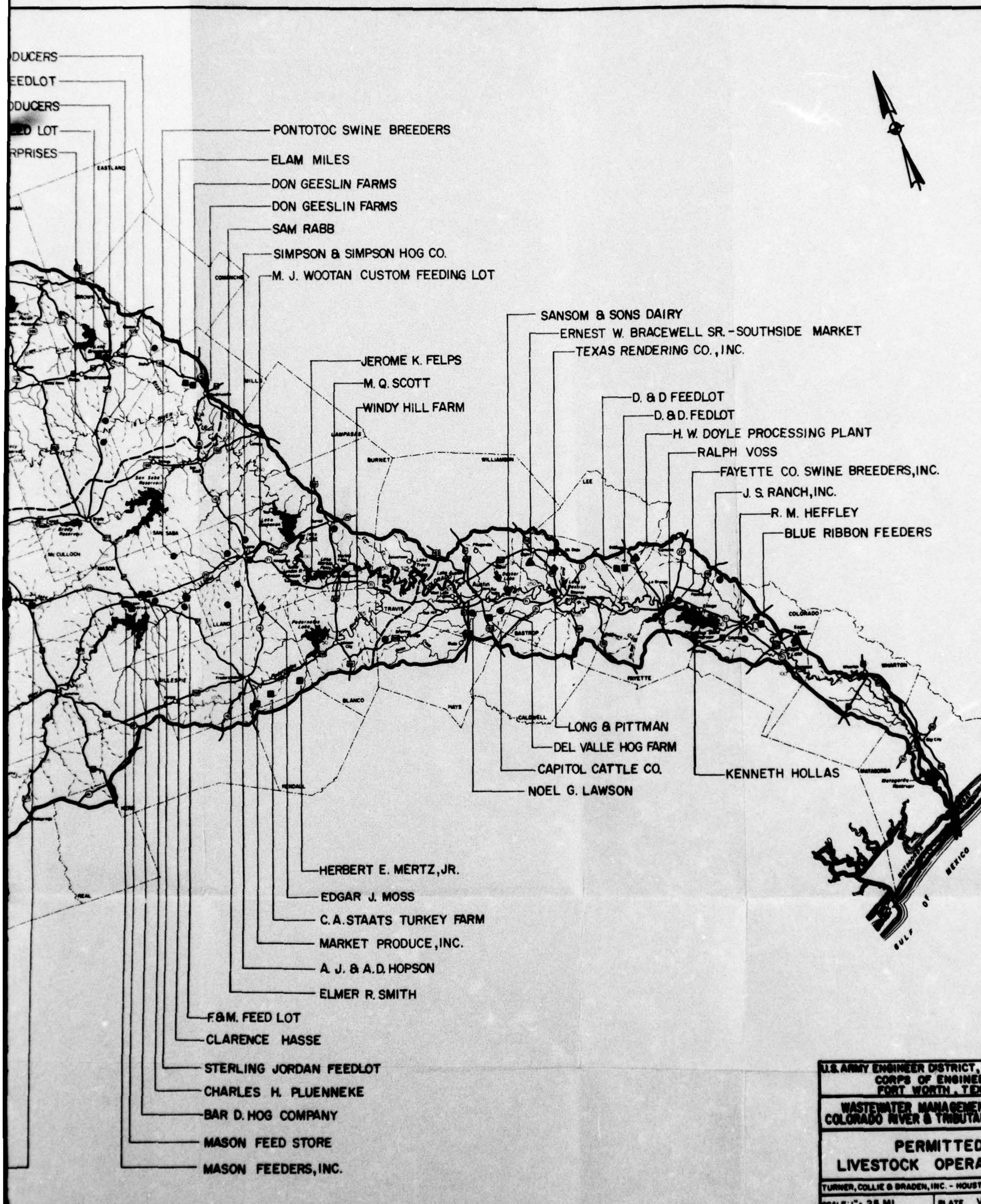
TABLE V - 6

SUMMARY OF PERMITTED LIVESTOCK OPERATIONS IN THE COLORADO RIVER BASIN

Facility	Number	Total Capacity*	Range in Capacity
Cattle Transfer and Holding	1	40,000	–
Commercial Swine Production	25	31,662	26- 5,750
Dairy	2	375	75 & 300
Feedlot			
Cattle	12	101,800	1,000-20,000
Sheep	3	75,000	10,000-35,000
Swine	4	2,643	200- 1,000
Swine and Cattle	1	–	–
Turkey	3	85,500	15,000-43,000
Rendering Plant	2	–	–
Slaughterhouse	4	–	–

**Animal Units*


ALPHA PORK PRODUCERS
GENE DOSS FEEDLOT
BEAN-DRISKILL SWINE PRODUCERS
B. H. YEAGER FEED LOT
BEAKLY BROS. ENTERPRISES
W. L. SCHROEDER MEAT CO.
EZELL-KEY GRAIN CO., INC.
STRUBE MARKET & LOCKER
WIN-TEX CATTLE FEEDERS, INC.
NEW MEXICO
BACA CATTLE FEEDERS
TEXAS CALF PALACE, INC.
LEGEND
COMMERCIAL SWINE PRODUCTION
FEEDLOT (CATTLE, SHEEP, ETC.)
SLAUGHTER HOUSE
RENDERING PLANT
DAIRY
LIVE OAK FARM
SAN ANGELO FEED YARDS, INC.
DON WAGGONER
SAN ANGELO BY-PRODUCTS, INC.
GENE NEWMAN DBA VERIBEST CATTLE FEEDERS
LARRY F. OXLEY
MARVIN GOETZ
KOTHMANN COMMISSION CO.



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

PERMITTED
LIVESTOCK OPERATIONS

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 25 MI. PLATE V-3

2

With the exception of farrowing houses, which are dry areas for the sows and pigs, swine production in the Basin is open feeding lots. Finishing operations are primarily open dirt lots. As seen in Table V-7, swine are second only to cattle in contribution of wastes under confined feeder operations.

Like swine, goats and sheep are usually raised under range conditions. The practice of confined feeding of sheep is primarily for mutton production. The three sheep feedlots for which waste control permits have been issued can accommodate 10,000, 30,000, and 35,000 head respectively. The range of typical waste and wastewater from sheep feedlots is noted in Table V-7.

High nitrogen and phosphorous concentrations (Table V-7) are characteristic of the wastes from poultry feedlots. Three turkey feedlots in the Basin, all located in Gillespie County, have been issued waste control orders by the TWQB. The feedlots range in size from 15,000 to 43,000 bird capacity. There are also various chicken operations ranging from egg production to raising broilers. Chicken production operations currently are not issued waste control permits; consequently, little is known of the size or the various methods of operation. In general, runoff from the pen area and/or the disposal site over which the feces is spread is the primary source of water pollution from these poultry operations.

The process operations, rendering plants, and slaughterhouses (abattoirs) also produce large quantities of organic-laden wastewater. This waste, in the case of abattoirs, is primarily composed of blood and large concentrations of solids. Depending on the amount of dilution, blood alone can exert a biochemical oxygen demand (BOD) in excess of 2,000 mg/l. According to Eckenfelder, an average of 800 gallons of wastewater, containing 13 pounds of BOD and 9.8 pounds of suspended solids, is produced per 1,000-pound live weight killed in the abattoir. Wastewater from rendering plants also has high concentrations of oils and fatty substances. It should be noted here that increasing numbers of these process operations are having their wastewater treated by municipal wastewater treatment facilities. This type of arrangement is usually highly favored by the process operations. However, care should be exercised to insure that the effluent from the abattoir receives sufficient pretreatment to prevent biological and/or hydraulic overloading of the municipal facility. Pretreatment can be required through an industrial waste ordinance.

TABLE V-7

TYPICAL FEEDLOT WASTE AND WASTEWATER CHARACTERISTICS[1]

	Cattle	Poultry	Sheep	Swine
* Quantity,[2] lbs./day	64-100	0.43	7.2	17.4
* Dry Organic Matter, lbs./day	8-13	–	–	–
* Moisture Content, %	79-84	72	77	78-85[5]
Total Nitrogen, lbs./ton Manure[3]	11.2-11.8	750	18	12-14
Phosphorus (P_2O_5), lbs./ton Manure[3]	1.5-2.0[4]	750	7.2	8-9
Potassium (K_2O), lbs./ton Manure[3]	8.1-10.2[4]	465	20.5	8-11
Biochemical Oxygen Demand				
mg/l	25,000-26,000	–	–	35,000
lbs./day	2.8	0.015	0.1-0.2	0.3

** Contribution Per Animal Unit*

[1] Range of Published Values

[2] Wet Manure and Urine, Unless Otherwise Noted

[3] Wet Manure

[4] Total Element Content

[5] Value for 200-lb. Hog

Currently, the predominant scheme utilized in the treatment of the waste (solid and liquid) from these livestock productions and processing operations is land disposal. As stated earlier, the TWQB does not permit discharge from these operations, and has imposed rather stringent provisions to insure that there is no discharge to surface water or ground water. This "no discharge provision" applies to the actual waste disposal site as well as the facility proper. The Board requires that the waste disposal retention facilities are to be sized to retain the runoff from a 25-year, 24-hour duration storm. According to Self-Reporting Data submitted by those operations in the Basin, there has been no discharge from these operations. This would tend to indicate that these operations currently do not present a significant pollution threat.

The Board is currently in the process of developing specific regulations governing the various types of livestock operations. Under the system, any person applying for a permit for a specific livestock operation is required to meet the criteria established in the respective regulation. Once these criteria have been met, the facility is certified under the regulation. Currently, there are two such regulations for livestock operations. The Commercial Swine Production Operation Regulation - Board Order 70-0828-4, and the Regulation on Meat Processing Operations - Board Order 71-0429-1. (Copy of each enclosed in Appendix J of the Basin Plan Appendix, Volume 2.) Highly controversial regulations regarding confined poultry feeding areas, confined cattle feeding areas, and wastes from dairy operations are currently being reviewed by the Board and its staff.

Sand and Gravel Washing Operations.

The nomenclature "sand and gravel washing operation" as used in this discussion refers to a variety of operations centered around sand and gravel needs. The TWQB has issued 14 waste control permits (see Table V-8) to companies for sand and gravel operations within the Basin. These authorizations cover 24 separate operations, the majority of which are the basic sand and gravel mining, washing, and sizing operations. It should be noted that although there are numerous basic operations, very few of them operate on a full-time basis.

TABLE V - 8

INVENTORY OF PERMITTED SAND AND GRAVEL WASHING OPERATIONS[1] IN THE COLORADO RIVER BASIN

NAME	WCO/CR[2] NUMBER	LOCATION	AVERAGE DAILY[3] EFFLUENT VOLUME (MGD)		REMARKS
			Permitted	Present	
BRYAN'S CONCRETE COMPANY	20328	Coke Co.—immediately E of State Hwy. 208, and immediately N of the Colorado River at a point approx. ½ mile S of the intersection of State Hwys. 158 and 208 •• Operation in immediate drainage area of the Colorado River (about RM 712.4).	n.d.	n.a.	Complete recycle of process water.
CAPITOL AGGREGATES, INC.	00486-01	Travis Co.—N bank of the Colorado River, approx. ½ mile downstream from the City of Austin's Govalle Sewage Treatment Plant (about RM 287.75).	0.12	n.d.	This initial operation is an asphaltic concrete plant, while the second facility is a ready-mix concrete plant. Neither of the two operations are currently in operation.
	00486-02	Travis Co.—same location as above.	0.03	n.d.	
CAPITOL AGGREGATES, INC.	00487	Travis Co.—S bank of the Colorado River, immediately E of Pleasant Valley Road, and approx. 300' downstream from the Town Lake Dam (Longhorn Dam) (about RM 291).	1.8	1.5	The company plans to abandon this facility early in 1973, and replace it with a new facility which will recycle the attendant wastewater, resulting in no discharge from the facility.
COLORADO SAND & GRAVEL CO.	00488	Mitchell Co.—S bank of the Colorado River, S of Colorado City, approx. 4300' S of the intersection of FM 471 and 377 (about RM 794).	0.0202	n.a.	
ELGIN-BUTLER BRICK CO.	00444	Bastrop Co.—immediately W of FM 696, approx. 1.5 miles N of U.S. Hwy. 290 •• Operation in drainage area of Big Sandy Creek.	n.d.	n.d.	Brick and Tile Manufacturing operation.
ELGIN-BUTLER BRICK CO.	01414	Bastrop Co.—approx. 2.0 miles N of the intersection of FM 696 and U.S. Hwy. 290, and E of FM 696 •• The operation is in the Big Sandy Creek watershed.	n.d.	n.d.	Manufactures structural clay products.
GIFFORD-HILL AND CO., INC.	01328	Colorado Co.—E of the Colorado River, approx. 1.33 miles NNW of the intersection of FM 950 and 2614 •• Discharges into natural slough — Colorado River (about RM 101.2).	2.88	2.88	Pertinent Effluent Quality Data is as follows: Parameter — Monthly Average Value: Permitted (not to exceed) / Present TSS, mg/l — 20 / 14.1 Set. Matter, mg/l — 5 / n.a.
R. E. JANES GRAVEL CO., INC.	20326	Borden Co.—approx. 4.0 miles NE of the intersection of FM 1584 and 1785, and approx. 3.5 miles NW of the intersection of FM 1785 and 669 •• The facility is in the drainage area of Plum Creek.	n.d.	n.d.	
W. L. JOHNSON SAND & GRAVEL CO.	00704	Coke Co.—S of the Colorado River, approx. 24 miles SE of the intersection of FM 2034 and State Hwy. 208 •• Effluent discharged to the Colorado River via channel (about RM 708.0).	0.315	n.a.	The following effluent standards apply: (monthly average not to exceed) TSS—100 mg/l and pH range of 6.2 - 8.5. The operation was shut down to allow cleaning of the outfall channel and as such current effluent data is not available.

[1](a) General category – any facility which is not specifically a sand and gravel washing operation is so noted in the "Remarks."
(b) Present characteristics, quality and quantity, of effluent were taken from TWQB Self Reporting Data for the current reporting period, July 1971 - June 1972.
(c) Settling (in ponds, pits, channels, etc.) is the treatment scheme.

[2]WCO—Waste Control Order; CR—Certificate of Registration (number begins with "2").

[3]Monthly average values.

TABLE V - 8 (Cont'd.)

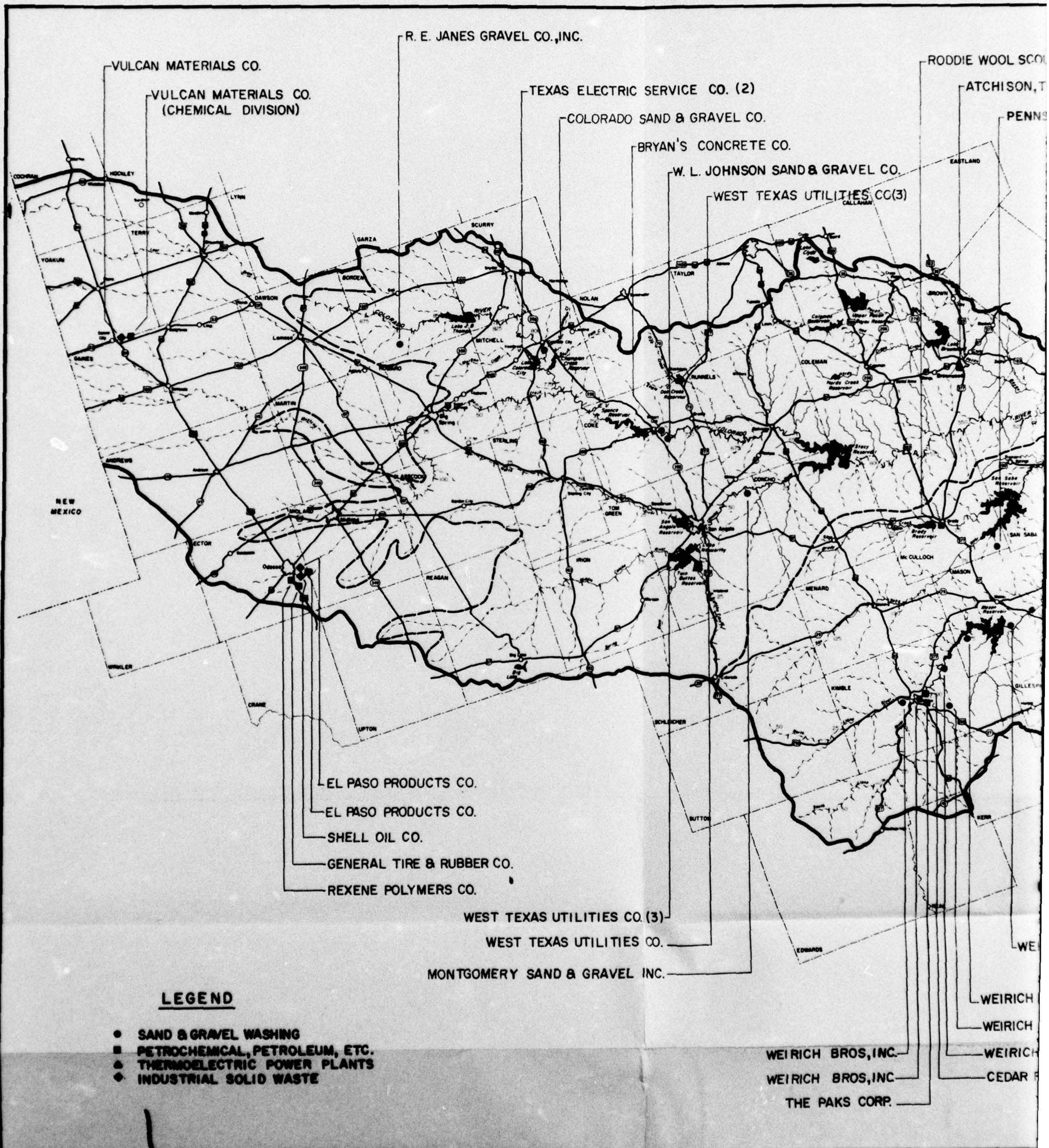
NAME	WCO/CR[2] NUMBER	LOCATION	AVERAGE DAILY[3] EFFLUENT VOLUME (MGD) Permitted	Present	REMARKS
LONE STAR INDUSTRIES, INC.	00641	Burnet Co.—approx. ½ mile E of U.S. Hwy. 281 and approx. 3 miles S of the City of Burnet on U.S. Hwy. 281 •• Discharges into Delaware Creek adjacent to the plant – Hamilton Creek – Lake Travis.	0.36	0.284	The operation is a limestone processing plant. Pertinent Effluent Quality Data is as follows: Parameter — Monthly Average Value: Permitted (not to exceed) / Present TSS, mg/l — 20 / 14 Set. Matter, mg/l — 5 / n.a.
LONGHORN SAND & GRAVEL, INC.	00776	Travis Co.—E bank of Colorado River, approx. 3.4 miles SSE of the intersection of FM 973 and 969 (about RM 276.3).	0.02	n.d.	
MONTGOMERY SAND & GRAVEL, INC.	01010	Tom Green Co.—approx. 200 yards W of FM 1692, and 1.6 miles S of the intersection of FM 1692 and 1929 •• Any discharge will be into the Concho River at a point approx. 200 yards upstream from the FM 1692 bridge over said river (about RM 40.5).	0.30	n.d.	The following effluent standards apply: (monthly average not to exceed) TSS—400 mg/l, and pH range of 5.5 - 8.5.
PENNSYLVANIA GLASS SAND CORP.	01680	McCulloch Co.—approx. 1.0 mile SE of the intersection of FM 1851 and State Hwy. 71, about 2.0 miles SE of the City of Voca •• The operation is located in Tiger Creek watershed – San Saba River.	n.d.	n.a.	Complete recycle of process water.
SOUTHWEST MATERIALS, INC.	20247	Travis Co.—immediately W of the Colorado River, approx. 3 miles N of the city of Garfield •• Any discharge is into the Colorado River (about RM 268.5).	0.48	n.a.	The following effluent standards apply: (monthly average not to exceed) TSS—20 mg/l and Settleable Solids of 5 mg/l.
WEIRICH BROS. INC.	00460-03	Blanco Co.—immediately E of Miller Creek, and approx. 7.0 miles E of Johnson City •• Any discharge is to said creek – Pedernales River.	See Remarks	n.d.	The operation is authorized to discharge wastewater to the holding ponds at a rate of 300 - 450 gpm.
	00460-04	Gillespie Co.—approx. 4 miles SE of Fredericksburg, and on E bank of Pedernales River at a point approx. 1.0 mile upstream from the U.S. Hwy. 290 bridge over said river (about RM 83.8).	n.n.d.	n.d.	Average flow to the settling pond is not to exceed 0.15 MGD. Any discharge is to meet the following effluent standards: (monthly average not to exceed) TSS—30 mg/l and Settleable Solids of 5 mg/l.
	00460-05	Mason Co.—N side of Llano River, and ½ mile E of the U.S. Hwy. 87 bridge over said river (approx. RM 54.5)	See Remarks	n.d.	The operation is authorized to discharge wastewater to the holding ponds at a rate of 300 - 450 gpm.
	00460-06	Mason Co.—S side of Llano River, approx. 1.5 miles W of Castell, and approx. 15 miles SW of Mason.	See Remarks	n.d.	do
	00460-07	Mason Co.—N side of Llano River, just off FM 2389 about 8.0 miles S of Mason.	See Remarks	n.d.	do
	00460-08	Kimble Co.—E side of Llano River, just off FM 385 about 7.0 miles S of London.	See Remarks	n.d.	do
	00460-09	Kimble Co.—W side of the Llano River, approx. 2 miles W of the U.S. Hwy. 83 and about 2 miles N of Junction.	See Remarks	n.d.	do
WEIRICH BROS., INC.	01341	Kimble Co.—immediately E of RR 2169, approx. 3400' NW of the intersection of RR 2169 and FM 1534 •• Any discharge will be into Johnson Fork Creek at a point adjacent to the plant – Llano River.	n.n.d.	n.d.	Average flow to the settling pond is not to exceed 0.15 MGD. Any discharge is to meet the following effluent standards: (monthly average not to exceed) TSS—30 mg/l and Settleable Solids of 5 mg/l.
WEIRICH BROS., INC.	01346	Kimble Co.—E bank of Llano River at a point approx. ½ mile downstream from the confluence of the South and North Llano Rivers (about RM 109.8) •• Any discharge will be into the Llano River adjacent to the plant.	n.n.d.	n.d.	Average flow to the settling pond is not to exceed 0.15 MGD. Any discharge is to meet the following effluent standards: (monthly average not to exceed) TSS—20 mg/l and Settleable Solids of 5 mg/l.

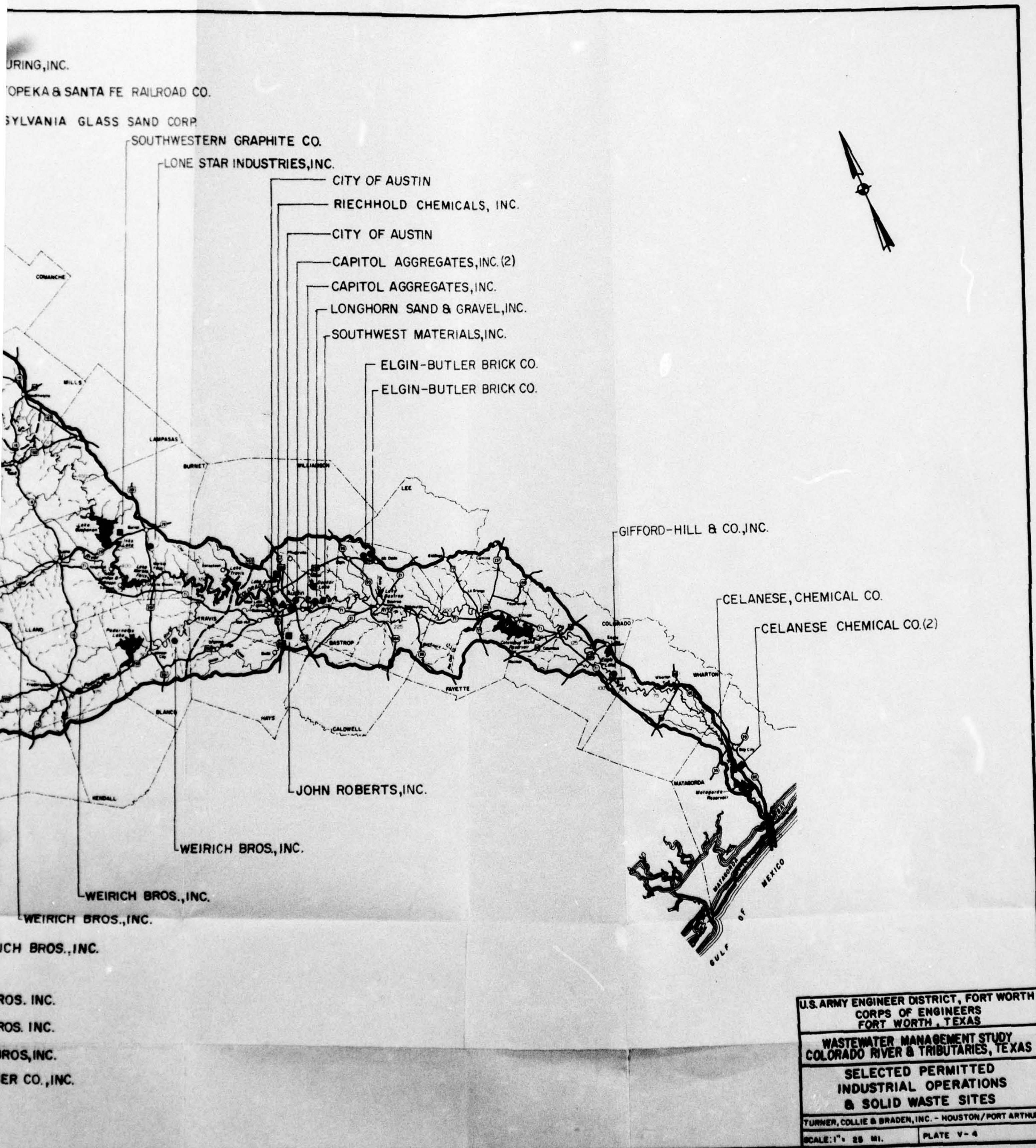
Most of these basic operations divert water from an adjacent stream for washwater or makeup water, thus the reason for their close proximity to watercourses (see Plate V-4). In many cases the water is recycled with virtually no discharge to a receiving watercourse, while in other cases virtually direct discharge occurs. Wastewater (washwater) from these operations contains suspended inert materials and trace amount of organic substances. The primary method of treating the wastewater is by settling. Since the settling ponds, pits, etc., as well as the physical operation, are usually located adjacent to a stream, proper treatment of the wastewater is imperative.

As seen in Table V-8, only three facilities reported a discharge during the period of record. All of those discharging were in compliance with their permitted effluent volume, and appeared to be in compliance with the permitted effluent quality criteria. The three flows represented an average daily flow of 4.66 mgd. According to the Self-Reporting Data, sixteen facilities did not discharge and the discharge status of the remaining five facilities is unknown. During the period of record, around ten of the operations were supposedly shut down, and obviously reported no discharge.

The pollution potential of wastewater generated by sand and gravel operations lies in the high concentration of suspended and colloidal particles. Thus, the pollution mechanism is very similar to that outlined in the discussion of water treatment plants. As witnessed in the files of the TWQB, there are documented instances of significant amount of virtually "untreated" wastewater being discharged to the Colorado River. While there are no biological or chemical data available to evaluate the effect of these discharges on the stream, the presence of sizable bars, formed by the continual deposition of solids from these discharges, is conspicuous evidence of the physical reality of the situation.

In view of the above circumstances, the TWQB has moved to correct this problem of unauthorized discharges and improperly treated discharges from sand and gravel operations. The most immediate action was naturally to have the specific discharger causing the problem take corrective measures. In an effort to deter such actions in the future, the TWQB adopted a regulation concerning sand and gravel washing operations and discharges therefrom. (Copy of regulation included in Appendix J of the Basin Plan Appendix, Volume 2.) Under the regulation, persons applying for a waste control permit for a sand and gravel operation must meet the specific treatment and effluent quality criteria detailed in the regulation. Once the Board is assured that the criteria are met, the facility is certified under the registration. One of the key points of the


R. E. JANES GRAVEL CO.,INC.
VULCAN MATERIALS CO.
VULCAN MATERIALS CO. (CHEMICAL DIVISION)
TEXAS ELECTRIC SERVICE CO. (2)
COLORADO SAND & GRAVEL CO.
BRYAN'S CONCRETE CO.
W. L. JOHNSON SAND & GRAVEL CO.
WEST TEXAS UTILITIES CO(3)
RODDIE WOOL SCOU
ATCHISON,T
PENNS
COCHRAN
HOCKLEY
LYNN
TERRY
YOAKUM
DAWSON
GAINES
GARZA
BORDEN
SCURRY
MITCHELL
NOLAN
TAYLOR
CALLAHAN
EASTLAND
BROWN
COLEMAN
RUNNELS
COKE
STERLING
MARTIN
ANDREWS
NEW MEXICO
ECTOR
WINKLER
CRANE
UPTON
REAGAN
IRION
TOM GREEN
CONCHO
MENARD
McCULLOCH
MASON
SAN SABA
KIMBLE
SCHLEICHER
SUTTON
KERR
EDWARDS
GILLESPIE
EL PASO PRODUCTS CO.
EL PASO PRODUCTS CO.
SHELL OIL CO.
GENERAL TIRE & RUBBER CO.
REXENE POLYMERS CO.
WEST TEXAS UTILITIES CO. (3)
WEST TEXAS UTILITIES CO.
MONTGOMERY SAND & GRAVEL INC.
WEI
WEIRICH
WEIRICH
WEIRICH
CEDAR
WEIRICH BROS,INC.
WEIRICH BROS,INC.
THE PAKS CORP.
LEGEND
SAND & GRAVEL WASHING
PETROCHEMICAL, PETROLEUM, ETC.
THERMOELECTRIC POWER PLANTS
INDUSTRIAL SOLID WASTE



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

SELECTED PERMITTED
INDUSTRIAL OPERATIONS
& SOLID WASTE SITES

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 25 MI. PLATE V-4

2

regulation is that specific quality criteria are detailed for any discharge from these facilities. These quality criteria are as follows: the concentration of settleable matter shall not exceed 5 mg/l and total suspended solids shall not exceed 20 mg/l (both values are monthly averages).

Thermoelectric Power Generation Operations.

There are currently nine thermoelectric power generation plants in the Colorado River Basin. Six of the nine have been issued waste control orders by the TWQB. The remaining three operations--one in Denver City, and one each on Lake Bastrop and Decker Lake--are essentially closed-system operations and thus no waste control order has been issued. In addition to those existing permitted operations, the TWQB has issued a permit to the Lower Colorado River Authority (LCRA) for the thermoelectric power plant currently under construction near Lake Lyndon B. Johnson. The facility is scheduled to go on line in 1974, and the TWQB has permitted an average discharge volume of 821.5 mgd, the largest permitted discharge in the Basin.

The permitted existing facilities are located within four counties (see Plate V-4). Two each are located in San Angelo and Austin. All of the power plants discharge into reservoirs. Of the receiving reservoirs, Town Lake, Lake Colorado City and Oak Creek Reservoir are sources of municipal water supply.

The permitted effluent volumes vary from a mere 2.3 mgd for the Concho Power Station on Bell Street Lake (in San Angelo) to 720.0 mgd for the Morgan Creek Steam Electric Plant, which is located on Lake Colorado City. With the exception of Seaholm and Holley Street Power Plants, the permitted facilities have discharged in compliance with their permitted discharge volumes during the period of record. Total average daily discharge from the facilities during the period of record was approximately 1,117.9 mgd.

Wastewater discharges from the plants consist primarily of once-through cooling water. Small amounts of water treatment and boiler cleaning wastes are also generated at these power plants, with the water treatment wastes usually being discharged with the cooling water. However, as seen in Table V-9, the highly acidic boiler cleaning wastes are disposed of by evaporation. Pertinent effluent quality data for the facilities are delineated in Table V-9.

TABLE V - 9
INVENTORY OF PERMITTED THERMOELECTRIC POWER GENERATION OPERATIONS IN THE COLORADO RIVER BASIN

Name	WCO Number	Location	Nature of Wastewater	Average Daily Effluent Volume (MGD)		Effluent Quality Data: pH Range		TSS (mg/l)		Total Residue (mg/l)		Temp (°F)	
				Permit	Present	Permit	Present	Permit	Present	Permit	Present	Permit	Present
AUSTIN, CITY OF (SEAHOLM POWER PLANT)	10543-05	Travis Co.—N side of Town Lake, E of the Missouri-Pacific RR Bridge over Town Lake, adjacent to Shoal Creek, and further defined at 800 W 1st Street •• The effluent is discharged into Shoal Creek approx. 900' upstream of the point where the Creek enters Town Lake.	Once through cooling water	108.6	140.1	–[1]	–	–[1]	–	–[1]	–	7[2]	82-86
AUSTIN, CITY OF (HOLLY STREET POWER PLANT)	10543-06	Travis Co.—N side of Town Lake, immediately upstream from Longhorn Dam, and further defined as being at 2400 Holly Street •• The effluent is discharged into Town Lake from a 1100' mixing channel approx. 450' upstream from Longhorn Dam.	Primarily once through cooling water	202.0	262.2	–[1]	–	–[1]	–	–[1]	–	10[2]	83-88
TEXAS ELECTRIC SERVICE CO. (MORGAN CREEK STEAM ELECTRIC PLANT)	00564-01 (Outlet 1)	Mitchell Co.—E side of Lake Colorado City, W of State Hwy. 163, approx. ½ mile W of the point on State Hwy. 163 which is approx. 1.3 miles S of its intersection with FM 1229 •• Discharges into a cooling water canal, which enters Lake Colorado City approx. ½ mile N of the spillway.	Once through cooling water, boiler blowdown, and other water treating wastes	720.0	310.0	6.2-8.5	7.8-8.9	10[2]	–	100[2]	4	22[2]	10-20
	00564-02 (Outlet 2)	The effluent from the cooling water canal enters Lake Colorado City at a point approx. 1.6 miles W of a point approx. ½ mile S of the intersection of State Hwy. 163 and FM 1229.	Same as Outlet 1	380.0	283.9	6.2-8.5	8.1-8.9	10[2]	–	100[2]	4	+20[2]	11-20
WEST TEXAS UTILITIES CO. (CONCHO POWER STATION)	00965	Tom Green Co.—in City of San Angelo, W bank of Bell Street Lake, S and E of the intersection of East Avenue H and Burgess Street •• The effluent is discharged into Bell Street Lake at a point approx. 8700' upstream from Lone Wolf Dam.	Misc. cooling water—68.57%, cooling tower blowdown—25.22%, filter backwash water—2.61%, boiler blowdown—1.98%, other—0.64%.	2.3	0.011	6.0-9.0	7.8-8.8	n.s.	–	2200	1,108	96	81-85
WEST TEXAS UTILITIES CO. (OAK CREEK POWER STATION)	00897-01 (Outlet 1)	Coke Co.—W of State Hwy. 70, at a point approx. 0.35 miles N of the point where the above Hwy. crosses Kaiser Creek •• Discharge from the cooling water system to Oak Creek Reservoir, S of the generating plant.	Once through cooling water	87.6	50.8	n.s.	8.1-8.5	n.s.	18	n.s.	425	16[2]	80-108
	00897-02—05 (Outlet 2)	•• Effluent discharges into Oak Creek Reservoir N of the generating plant.	Once through cooling water—99%, blowdown from water softener, evaporator blowdown, filter backwash, misc. waste water—1%.	Variable	0.52	n.s.	8.1-8.5	n.s.	26	n.s.	424	n.s.	82-100
	00897-08 (Outlet 3)	•• No discharge.	Boiler cleaning waste	n.d.[3]	n.d.	–	–	–	–	–	–	–	–

[1] No increase over influent quality.

[2] Increase over influent quality.

[3] Effluent discharged to evaporation pits.

Note: Present effluent data values are simple averages of TWQB Self Reporting Data for the period July 1971 - June 1972.

TABLE V - 9 (Cont'd.)

Name	WCO Number	Location	Nature of Wastewater	Average Daily Effluent Volume (MGD)		Effluent Quality Data: pH Range		TSS (mg/l)		Total Residue (mg/l)		Temp (°F)	
				Permit	Present	Permit	Present	Permit	Present	Permit	Present	Permit	Present
WEST TEXAS UTILITIES CO.	01152-01 (Outlet 1)	Tom Green Co.—W of Lake Nasworthy, approx. 30 miles SSW of the intersection of State Hwy. 308 and FM 584 •• Discharge to Lake Nasworthy via drainage canal.	Cooling water and boiler blowdown	115.0	70.4	6.5-8.5	8.5-8.7	1[2]	37	n.s.	–	110	84-106
	01152-02 (Outlet 2)	•• No discharge	Backwash and rinse from zeolite softener	n.d.[3]	n.d.	–	–	–	–	–	–	–	–
	01152-03 (Outlet 3)	•• No discharge	Boiler cleaning waste	n.d.[3]	n.d.	–	–	–	–	–	–	–	–

While these discharges do not usually contain significant amounts of chemical or biological "pollutants," they pose a significant thermal pollution threat. Initially, such discharges can cause a definite increase in the temperature of the receiving stream. Such an increase can cause a decrease in the saturation level of dissolved oxygen while increasing the rate of oxygen-demanding chemical and biological reactions--the net result of these circumstances being a decrease of the dissolved oxygen level and the assimilative capacity of the stream.

The Department of the Interior's analysis of steam-electric power plants cooling water discharges indicates an average increase of 15°F in the temperature of water passing through condensers. Based on the total average daily flow from the permitted facilities within the Basin (1,117.9 mgd), an average of approximately 140 billion Btu/day of heat is being discharged into the receiving reservoirs. In view of this sizable transfer of heat, the potential of thermal pollution is obvious. However, it is noted that currently there is no known evidence of thermal pollution in the receiving reservoirs within the Colorado River Basin.

The TWQB and respective power companies are working together to insure that thermal pollution does not become a problem in the Basin. One such example is the extensive ecological study of Lake Lyndon B. Johnson currently being conducted by the LCRA. The results of this study will be used by the TWQB to establish a mixing zone for the discharge from the power plant scheduled to go on line in 1974. It should be noted that the study will not terminate with the startup of the facility, but rather will continue to evaluate the effect, if any, of the discharge on the flora and fauna of the Lake.

Heavy Industrial Operations.

Whereas most of the permitted industrial operations in the Basin were readily classified under one of the above wastewater source categories, there were twelve operations which did not fall into one of the above categories. These twelve operations are considered herein.

The operations, which are scattered throughout the Basin (see Plate V-4), vary from a wool-scouring operation in Brady to the sizeable petroleum and petrochemical complexes. As seen in Table V-10, six of the twelve operations are either petrochemical or chemical-related industries. Two cedar oil mills, one railroad yard, one jewelry manufacturer, one graphite mining operation, and a wool-scouring operation constitute the remainder of the so-called "heavy" industrial operations.

TABLE V - 10

INVENTORY OF PERMITTED HEAVY INDUSTRIAL OPERATIONS IN THE COLORADO RIVER BASIN

Name	TWQB Number	Type of Industry	Location	Nature of Wastewater and Method of Treatment	Average Daily Effluent Volume (MGD)		Effluent Quality: pH Range		Temperature (°F)		Total Residue (mg/l)		Suspended Solids (mg/l): Total		Suspended Solids (mg/l): Volatile		COD (mg/l)	
					Per.*	Pres.*	Per.	Pres.	Per.	Pres.	Per.	Pres.	Per.	Pres.	Per.	Pres.	Per.	Pres.
ATCHISON, TOPEKA & SANTA FE RAILROAD COMPANY (Brownwood Railroad Yard)	00720	Railroad shop area, locomotive fueling facility and unloading area.	Brown Co.—in the City of Brownwood, N of the intersection of Avenue C and Jeff Davis St., S of the Railroad, approx. ½ mile W of the intersection of FM 2524 and said Railroad •• Discharges into an open drain, and flows SE approx. 7500' before entering Salt Creek – Willis Creek – Pecan Bayou.	A gravity type oil/water separator is used to salvage fuel oil from the attendant wastewater and stormwater runoff.	0.002	0.001	6.0-8.0	7.1-7.3	95	62-82	600	234	20	13	15	8	200	104
CEDAR FIBER CO., INC.	01412	Cedar Oil Mill	Kimble Co.—N of FM 2169, and 2 miles NE of the intersection of U.S. Hwy. 290 and FM 2169 •• No discharge.	The wastewater (98% process water and 2% boiler blowdown) is totally retained in a holding pond.	n.d.	n.d.	–	–	–	–	–	–	–	–	–	–	–	–
CELANESE CHEMICAL CO.	00495	Petrochemical plant	Matagorda Co.—near the W end of FM 3057, approx. 3 miles W of 2668, and further defined as being approx. 8 miles S of Bay City •• Effluent is discharged into the Colorado River just below the head of the navigation (about RM 22.5).	Low strength process water-aerated lagoons; high strength-wastewater-evaporation ponds and injection well; domestic sewage – Extended aeration package plant.	1.80	1.21	6.0-9.5	7.4-8.6	100	70-94	7,000	3,130	75	40	90	17	200	48
EL PASO PRODUCTS CO.	01304	Petrochemical plant	Ector Co.—approx. 1 mile SE of Odessa, in an industrial complex between IH 20 and Monahans Draw •• No discharge.	Process water, cooling water, boiler blowdown and water treatment waste – lined holding ponds, filtration equipment, sludge thickener, vacuum extractor, incinerator and injection well.	n.d.	n.d.	–	–	–	–	–	–	–	–	–	–	–	–
GENERAL TIRE & RUBBER CO.	00017	Manufacture BD-Styrene, synthetic rubber.	Ector Co.—S of IH 20, approx. 0.9 miles SE of the intersection of IH 20 and U.S. Hwy. 385, S of Odessa •• No discharge.	Cooling tower water and other process waters-holding and evaporation ponds. The ponds are sized to hold the waste for approx. a ten year period.	n.d.	n.d.	–	–	–	–	–	–	–	–	–	–	–	–
THE PAKS CORPORATION	01301	Cedar Oil Mill	Kimble Co.—just E of FM 2169, approx. 1 mile N of the intersection of FM 2169 and U.S. Hwy. 290 •• Discharges into Johnson Creek at a point approx. 250' downstream from the FM 2169 bridge over Johnson Creek – Llano River.	Cooling water (98%) and boiler blowdown (2%) – settling and cooling ponds.	0.72	0.720	6.0-9.5	6.9-7.8	95	60-90	800	242	20	7	–	–	60	24
REICHHOLD CHEMICALS, INC.	01304	Chemical Manufacturing	Travis Co.—E of FM 1325, 1.3 miles N of the intersection of U.S. Hwy. 183 and FM 1325 •• Any discharge will be to the City of Austin's sanitary sewer system.	Process waters – concentrated wastes retained in lined holding ponds; remainder is temporarily retained in lined holding ponds and then discharged to City of Austin's sanitary sewer system.	n.d.	n.d.	–	–	–	–	–	–	–	–	–	–	–	–

*Per.—Permitted; Pres.—Present.

Note: Present effluent data values are simple averages of TWQB Self Reporting Data for the period July 1971 - June 1972.

TABLE V - 10 (Cont'd.)

Name	WQO Number	Type of Industry	Location	Nature of Wastewater and Method of Treatment	Average Daily Effluent Volume (MGD)		pH Range		Temperature (°F)		Total Residue (mg/l)		Suspended Solids (mg/l) Total		Suspended Solids (mg/l) Volatile		BOD (mg/l)	
					Per.*	Pres.*	Per.	Pres.	Per.	Pres.	Per.	Pres.	Per.	Pres.	Per.	Pres.	Per.	Pres.
JOHN ROBERTS, INC.	01288	Jewelry Manufacturing	Travis Co.—W of IH 35 approx. 1 mile S of Austin, and further defined as being about 2 miles N of the intersection of IH 35 and FM 1327 •• Discharge into an unnamed creek approx. 1200' above the confluence of said creek and Boggy Creek.	Domestic sewage – extended aeration package plant with chlorination.	0.01	0.003	–	–	–	–	–	–	20	54	–	–	20[1]	20[1]
[illegible] WOOL SCOURING, INC.	01387	Wool scouring	McCulloch Co.—E of the intersection of South Magnolia Street and East Second Street in Brady, and SW of the intersection of Gulf, Colorado, and Santa Fe R.R. and FM 714 •• No discharge.	Wool scouring wastewater – completely retained in sedimentation pits and evaporation ponds.	n.d.	n.d.	–	–	–	–	–	–	–	–	–	–	–	–
SHELL OIL COMPANY (Odessa Refinery)	01437	Petroleum Refinery	Ector Co.—on South Grandview Avenue, approx. 1.5 miles SE of the intersection of IH 20 and U.S. Hwy. 385 •• No discharge.	Cooling tower blowdown (10%), process water (50%), and boiler blowdown (40%) – holding pond with oil skimmer, API separator, surge tank, retention pond, and irrigation facilities.	n.d.	n.d.	–	–	–	–	–	–	–	–	–	–	–	–
SOUTHWESTERN GRAPHITE CO.	02580	Graphite Mining and Extracting	Burnet Co.—immediately E of Clear Creek about 2.1 miles N of the State Hwy. 29 bridge over said Creek •• Discharge into Clear Creek – Inks Lake.	Process waste, mine drainage, and surface runoff – lined tailing pond, system of ditches and collection basins, neutralization of waste waters, and settling pond.	0.3	0.240	6.5-8.5	7.0-8.5	85	60-80	1,200	1,044	10	3	5	1	16	–
VULCAN MATERIALS CO., CHEMICAL DIVISION	02568	Manufacture Chlorine and Caustic	Yoakum Co.—immediately N of a county road, at a point approx. 1 mile E of the intersection of State Hwys. 214 and 83 •• No discharge.	Process water – completely retained in lined evaporation pond.	n.d.	n.d.	–	–	–	–	–	–	–	–	–	–	–	–

[1] BOD Data.

Only six of the twelve industries with discharge permits actually discharge. During the period of record, all five industries did discharge, and the total average daily flow from the five amounted to only 2.18 mgd. The majority of the flow (1.21 mgd) was discharged by the Celanese Chemical Company, the only heavy industrial operation which discharges directly into the Colorado River. Each of the five discharged in compliance with its respective permitted effluent volume.

From the quality standpoint, with the exception of effluent from the jewelry manufacturer and graphite mining operation, most of the effluent discharged is cooling water or low-strength process water. As seen in Table V-10, the high-strength concentrated wastes are disposed of by evaporation or deep well injection. A review of the Self-Reporting Data revealed that, with one exception, all of the discharges were in compliance with their respective effluent quality criteria.

While half of the heavy industrial operations discharge, the other six dispose of their wastewater primarily by evaporation. In one case, some of the effluent from the facility is used for irrigation. A portion of the wastewater from yet another plant is discharged into the City of Austin's sanitary sewer system after pretreatment. While the TWQB has imposed both quantity and quality requirements on the effluent from the treatment facilities to the holding pond, the industry is not required to submit such data in Self-Reporting. Consequently, no information was available as to the quantity or quality of the waste. Further, no information was available on the quantity or quality of the wastewater Reichold Chemicals, Inc. discharges to the City of Austin's sanitary sewer system.

Obviously, wastewater from these operations could pose a very imminent pollution threat. However, it appears that most of the more concentrated and dangerous wastes are properly disposed of by evaporation or deep well injection. Therefore, at present it doesn't appear that these sources, even those discharging, present any significant pollution threat.

Commercial-Industrial Solid Waste Disposal Facilities.

The improper disposal of industrial solid wastes poses a more prominent threat to water quality than municipal solid waste disposal. In recognition of this fact in 1969, the 61st Texas Legislature passed the Solid Waste Disposal Act (subsequently amended in 1971) which designated the TWQB as the State agency responsible for coordination

of all industrial solid waste activities in the State. Consequently, in August 1971, the TWQB, by Board Order No. 71-0820-18, adopted the regulation for the handling, storage and disposal of solid, semi-liquid and liquid waste from commercial-industrial disposal operations in the State of Texas. The regulation defines very explicit and detailed criteria for these types of disposal operations, as well as delineating a registration system. Under the registration system, an application for a Certificate of Registration is to be submitted to the TWQB for each concerned operation. When the Board is assured that the disposal operations are in accordance with the Regulation, a Certificate of Registration is issued.

To date, five such certificates have been issued in the Colorado River Basin to the following four industries:

Certificate Holder	Certificate Number
Celanese Chemical Company	20079
	20366
El Paso Products Company	20260
Rexene Polymers Company	20464
Vulcan Materials Company	20327

As seen in Plate V-4, with the exception of the Celanese Chemical Company, all of these industries are located in the upper portion of the Basin.

According to the information filed with the certificate applications, the disposal sites vary in size from small plats to multi-acre operations. The type of waste disposed varies from paper to complex organic and inorganic substances, many of which are flammable and some even toxic. On the average, the above five disposal sites receive a total of approximately 400 tons of wastes a day.

Undoubtedly one of the key provisions of the above certificates is that there is to be "no discharge" of any type from the facility into any waters of the State. Therefore, under present permit constraints, commercial-industrial solid waste disposal does not pose an imminent threat to the waters of the Colorado River Basin.

Residual Waste Disposal Policy.

At present the Texas Water Quality Board, pursuant to Chapters 21 and 22 of the Texas Water Code and the Solid Waste Disposal Act (Article 4477-7 Vernon's Civil Statues), is regulating the disposition of residual waste from industrial or municipal facilities. It is the intent of the Board to continue its past efforts in this area and to provide for the disposition of all residual waste from any municipal, industrial, or other water or waste-water treatment process, whenever the processing or disposal occurs within the Colorado River Basin.

Control is presently exercised through the issuance of appropriate waste control orders to dischargers. In cases where a significant amount of sludge is expected, the waste control order specifically sets forth the Board's policy toward sludge disposal. The following examples of "Sludge Disposal Clauses" delineate current Board policy relative to disposition of residual waste.

"Typical Sludge Disposal Clause" for municipal sewage treatment plants -

> "Any excess sludge resulting from the operation of facilities covered by this order shall be disposed of in such manner that no contamination of surface or ground-water can occur."

"Typical Sludge Disposal Clause" for confined feeding operations -

> "The Company shall provide waste control facilities to retain all wastewater flowing from cattle feeding pens and associated areas as a result of rainfalls of 8.6 inches or less which occur during any 24-hour period. Provisions shall be made to dewater retention facilities as soon as possible after rainfalls by irrigation of adjoining land with no runoff into the area streams. Provisions shall also be made for the removal of organic solids from drainage ditches and retention facilities when such facilities contain as much as 20% by volume of solids.
>
> "All solid waste materials (including dead animals, that result from feedlot cleaning operations, and the sludge deposited in retention facilities) shall be disposed of so that no contamination of surface or ground waters can occur."

"Typical Sludge Disposal Clause" for sand and gravel washing operations

> "When settled solids occupy 30% of the original capacity of any settling facilities described herein, the certificate holder shall cease all discharges into the affected facilities until such facilities are restored to their original capacity. This requirement in no way exempts the certificate holder from the responsibility to retain all wash water.

"The certificate holder shall place all settled solids which are removed from the settling facilities in landfills or previously excavated sand and gravel pits for disposal unless settled solids are reclaimed as a saleable product. The disposal areas shall be maintained in a condition such that the settled solids placed there cannot be resuspended by normal rainfall runoff from the area."

It is the intent of the TWQB to continue its past policies relative to the inclusion of sludge disposal provisions in its waste control orders. At such time as the Board obtains authority to issue Federal Permits under the National Pollutant Discharge Elimination System, it is envisioned that requirements for sludge disposal will be included in the permits. Presently, the TWQB foresees that a sludge disposal clause similar to the one below will be included in all NPDES Permits issued by the Board.

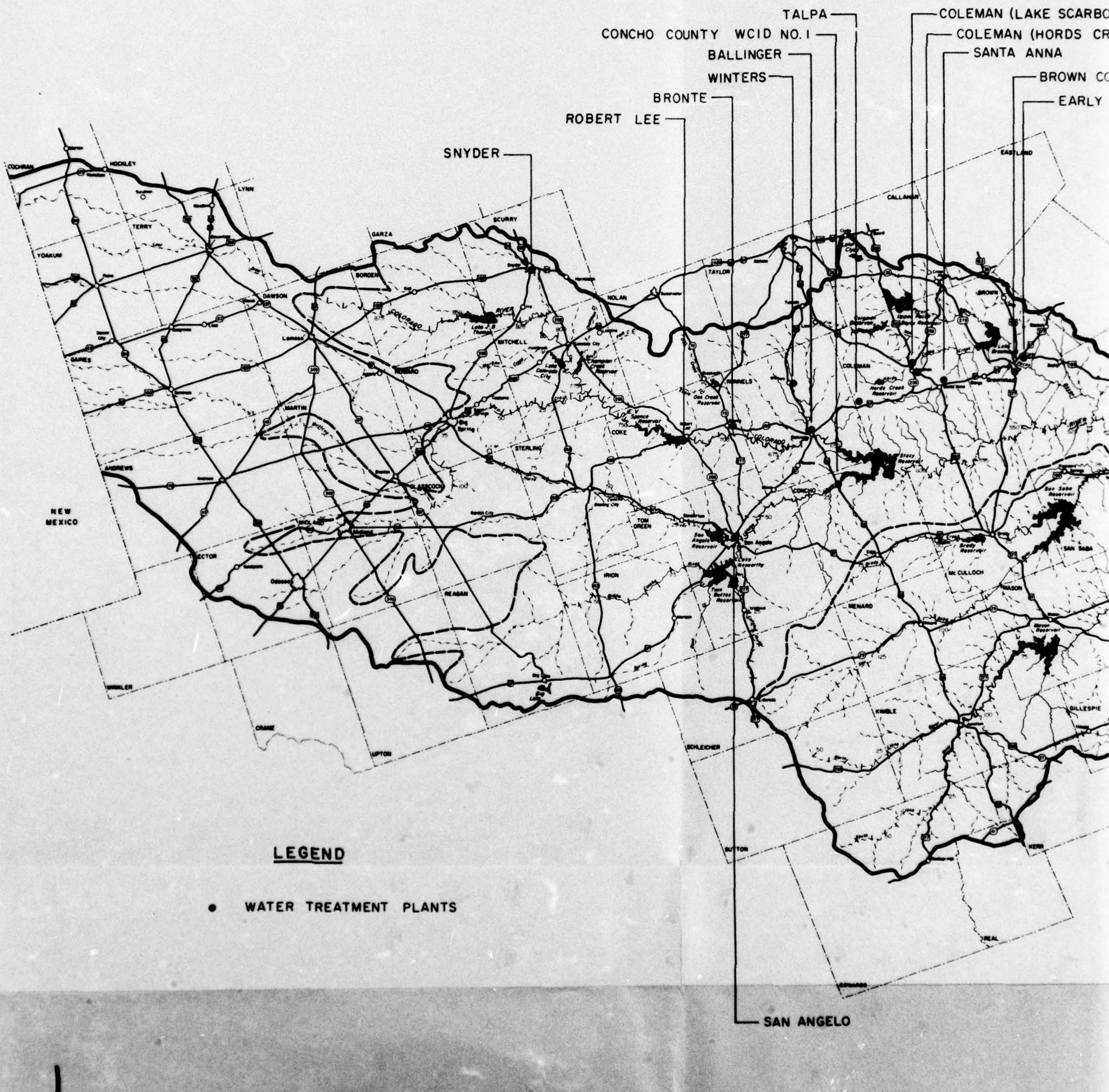
"Collected screenings, sludges, and other solids removed from water or liquid wastes shall be disposed of in such a manner as to prevent entry of such materials into the surface or ground waters of the State."

In special cases where more detailed sludge disposal conditions are required, they will be set forth in the permit. (Any specific sludge disposal clauses proposed for NPDES Permits will be detailed in Segment Plans.)

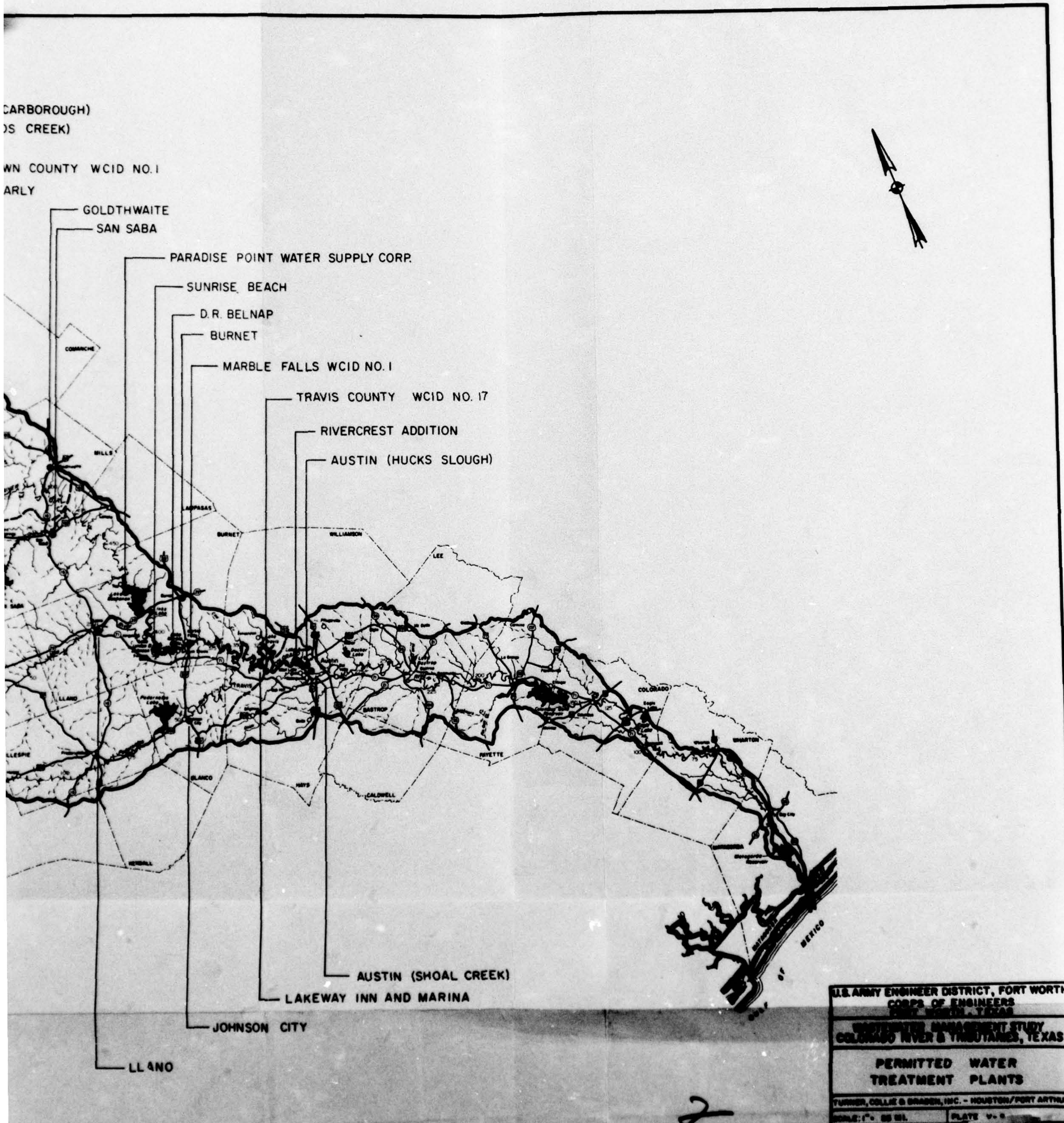
In addition to the regulation of disposition of residual waste by waste control orders, the Board also exercises control of industrial and commercial solid waste disposal sites pursuant to the provisions of the Solid Waste Disposal Act. Under this Act, the TWQB is granted power to register commercial or industrial solid waste disposal sites. Prior to the registration, it has been the policy of the Board to insure that sites and disposal practices are investigated to insure that the disposal of residual wastes would not pose a surface or subsurface water pollution problem. It is the intent of the Board to continue this policy.

__Water Treatment Plants.__

The TWQB has issued waste control orders for 27 water treatment plants in the Colorado River Basin (see Plate V-5). These facilities are owned and operated by private companies, special-purpose districts, and municipalities. It is noted that these 27 are not all of the water



TALPA
CONCHO COUNTY WCID NO. 1
BALLINGER
WINTERS
BRONTE
ROBERT LEE
SNYDER
COLEMAN (LAKE SCARBOR
COLEMAN (HORDS CRE
SANTA ANNA
BROWN CO
EARLY
SAN ANGELO
COCHRAN
HOCKLEY
LYNN
TERRY
YOAKUM
DAWSON
GAINES
GARZA
BORDEN
SCURRY
NOLAN
TAYLOR
CALLAHAN
EASTLAND
MITCHELL
HOWARD
MARTIN
ANDREWS
NEW MEXICO
COKE
STERLING
RUNNELS
COLEMAN
BROWN
CONCHO
TOM GREEN
IRION
REAGAN
ECTOR
GLASSCOCK
CRANE
UPTON
WINKLER
SCHLEICHER
MENARD
McCULLOCH
MASON
SAN SABA
KIMBLE
GILLESPIE
KERR
SUTTON
REAL
EDWARDS
COLORADO
LEGEND
WATER TREATMENT PLANTS



CARBOROUGH)
DS CREEK)
WN COUNTY WCID NO. I
ARLY
GOLDTHWAITE
SAN SABA
PARADISE POINT WATER SUPPLY CORP.
SUNRISE BEACH
D.R. BELNAP
BURNET
MARBLE FALLS WCID NO. I
TRAVIS COUNTY WCID NO. 17
RIVERCREST ADDITION
AUSTIN (HUCKS SLOUGH)
AUSTIN (SHOAL CREEK)
LAKEWAY INN AND MARINA
JOHNSON CITY
LLANO
COMANCHE
MILLS
LAMPASAS
BURNET
WILLIAMSON
LEE
LLANO
TRAVIS
BASTROP
FAYETTE
COLORADO
WHARTON
BLANCO
HAYS
CALDWELL
KENDALL
MATAGORDA
MEXICO
GULF OF
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
PERMITTED WATER
TREATMENT PLANTS
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE: 1" = 25 MI.
PLATE V-

2

treatment plants in the Basin, but rather only those which have received a waste control permit from the TWQB. These facilities are inventoried in Table V-10A.

According to Self-Reporting Data submitted by these facilities, only eight plants reported a discharge during the period of record. Of those reporting a discharge, the average discharge volumes ranged from 0.003 mgd to 0.518 mgd. The total average discharge from these facilities was approximately 1.06 mgd. The discharge from the City of Austin's Hucks Slough Water Plant represented approximately 50 percent of the 1.06 mgd.

Unfortunately only limited data were available on effluent quality from these sources. Of those reporting effluent quality, the average concentration of total suspended solids ranged from 4.9 to 632.6 mg/l.

In general, wastewater from water treatment plants consists of waste sludge and/or backwash water. Of the two, the most significant waste is calcium carbonate sludge, a by-product of the water-softening process which utilizes lime as the principal coagulant. The other constituent, filter backwash water, results from the periodic cleaning of the sand filtration units. Although small in volume, with respect to the amount of water filtered, backwash water contains a considerable amount of fines and suspended floc particles which are carried over from the clarification units.

The quality of the plant wastes may vary greatly, due to the chemical quality of the raw water treated and the amount and type of chemicals used in the treatment process. This variance is evidenced by the quality conditions listed on the various permits which range from "typical filter backwash water and spent-lime sludge" to "wash water not to exceed 150 ppm solids average nor the sludge to exceed an average of 6.25% solids (by weight)."

The pollution potential of discharges from water treatment plants is obviously associated with the high turbidity and suspended solids concentration. The presence of such large amounts of suspended and colloidal particles can impart color or a cloudy turbid appearance to the stream which is aesthetically unpleasing. The turbidity may then reduce light penetration into the stream, thus reducing the photosynthetic activity normally occurring in the stream. Subsequently, the reduction in photosynthetic activity will directly affect the dissolved oxygen concentration.

In cognizance of the PL 92-500, which looks to the eventual elimination of pollutant discharge, it is anticipated that increased waste sludge treatment technology will be implemented Basin-wide. It is also anticipated that treatment or total retention and evaporation of backwash water will be required by 1985. Despite the apparent pollution potential, there were no known violations of stream standards within the Basin caused by a discharge from a water treatment plant during the period of record. However, water treatment plant wastewaters can adversely affect water quality, and the Texas Water Quality Board will continue to give attention to this matter.

Urban Runoff.

Urban runoff--stormwater runoff--is recognized as one of the more significant wastewaters discharged from large urban areas. In fact, studies have demonstrated that urban runoff pollution load may equal the pollution load from a secondary wastewater treatment plant. Although the quality of the runoff is highly variable, some idea as to the probable quality of the runoff is seen in the results of samples of urban runoff taken in Washington, D. C.[1]

BOD_5	19 mg/l
Suspended Solids	1,697 mg/l
Total Phosphorus	1.3 mg/l
Total Nitrogen	2.1 mg/l
Fecal Coliform	310,000 (per 100 ml)

Dust and debris from airborne fallout, fertilizers, insecticides, material eroded from land and pavements, oily residues from vehicles and sanitary and industrial wastewaters (via illegal connections) contribute to the pollution potential of runoff from urban areas.

In numerous instances, combined sewer overflow results during periods of urban runoff. These overflows, in fact, tend to supplement the pollution potential of the urban runoff. However, this is not the case in the Colorado River Basin, for there are no known combined sewers in the Basin.

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[1] Weston, Roy F., Germain, James E., Fiore, Michael E., "Solving the Combined Sewer Overflow Problem of a Major City". Public Works, Vol. 103, No. 5 (May, 1972).

TABLE V-10A

INVENTORY OF PERMITTED WATER TREATMENT PLANTS IN THE COLORADO RIVER BASIN

Name	WCO Number	Location	Type of Wastewater	Effluent Volume[1]		Effluent Quality[1]	
				Permit	Present	Permit	Present
Austin, City of (Huck's Slough)	10543-01	Travis Co. – near junction of W. 35th St. & Huck's Slough in Austin •• Discharges into Huck's Slough – Lake Austin.	Filter wash water and calcium carbonate sludge	Wash water – 0.32 mgd Sludge – 0.072 mgd	Wash water – 0.518 mgd Sludge – n. a.	Wash water – 150 mg/l Sludge – 6.25% solids by weight	Wash water: TSS – 630 mg/l Sludge – n. a.
Austin, City of (Shoal Creek)	10543-02	Travis Co. – at the junction of Shoal Creek & E. 1st St. in Austin •• Any discharge will be into Shoal Creek – Town Lake.	Filter wash water and calcium carbonate sludge	Wash water–150,000 gpd Sludge–36,000 gpd	n. d.	Wash water – 150 mg/l Sludge – 6.25% solids by weight	n. a.
Ballinger, City of	10325-02	Runnels Co. – NW of the intersection of 5th St. & Kentucky St. in Ballinger •• Discharges to pasture area in immediate drainage area of the Colorado River.	Water treatment plant waste water	Current operating practice	n. d.	Treatment chemicals, sediments and backwash water	n. a.
Belknap, D. R.	10830	Burnet Co. – Approx. 1000 feet S. of Wirtz Dam at Lake Lyndon B. Johnson •• Discharge would be into Lake LBJ near the plant.	Water treatment plant wastes	5,000 gallons per week	n. d.	Turbidity less than 20 units	n. a.
Bronte, City of	10390-02	Coke Co. – Intersection of Washington & Jackson Sts. in Bronte •• Any discharge would be to unnamed tributary of Middle Kickapoo Creek – Kickapoo Creek – Colorado River.	Water treatment plant sludges and backwash	Current operating practice	n. d.	Treatment chemicals, sediments and backwash water	n. a.
Brown County WCID No. 1	10391	Brown Co. – near U.S. Hwy. 377 & SW of the City of Brownwood •• Discharges to a tributary of Pecan Bayou – Pecan Bayou – Colorado River.	Sludges and backwash water	Current operating practice	0.146 mgd	Treatment chemicals, sediments and backwash water	TSS – 5.0 mg/l
Burnet, City of	10793-01	Burnet Co. – Intersection of Tate St. and Main St. in Burnet •• Any discharge would be to Dougherty Branch – Hamilton Creek – Colorado River.	Water treatment plant waste water	30,000 gallons per day	n. d.	Turbidity less than 20 units	n. a.

[1] *Permit and present values represent monthly average values.*

TABLE V - 10A (Cont'd.)

Name	WCO Number	Location	Type of Wastewater	Effluent Volume[1]		Effluent Quality[1]	
				Permit	Present	Permit	Present
Coleman, City of (Hords Creek)	10150-03	Coleman Co. – Adjacent to North Mississippi St. in the Western Hills Addition, Coleman •• Discharge would be into an unnamed ditch – an earthen tank in the immediate drainage area of Hords Creek.	Water treatment plant wastewater	1,500,000 gallons/month	n. d.	Turbidity less than 20 units	n. a.
Concho Co. WCID No. 1	10815	Concho Co. – One block E of U.S. Hwy. 83 and NNE of the intersection of said hwy. and FM Road 380 in Paint Rock •• Any discharge will be into sedimentation pond with overflow, if any, to Hog Creek – Concho River – Colorado River.	Water treatment plant wastes	50,000 gallons/month	n. a.	Turbidity less than 20 units	n. a.
Early, City of	10782	Brown Co. – Adjacent to Hillcrest Rd., approximately 800 ft. E of U.S. Hwy. 67-84 •• Discharges into a drainage ditch – Pecan Bayou – Colorado River.	Water treatment plant wastewater	20,000 gallons/day	3,000 gpd	Turbidity less than 20 units	n. a.
Goldthwaite, City of	10489	Mills Co. – Approx. 1.5 miles SW of Goldthwaite on Hwy. 16 •• Discharge into unnamed tributary of Bull Creek – Bull Creek – Colorado River.	Water treatment plant wastes	10,000 gallons/day	n. a.	Turbidity less than 20 units	n. a.
Johnson City, City of	10198	Blanco Co. – 400 ft. E of the intersection of U.S. Hwy. 281 & U.S. Hwy. 290 in Johnson City •• Any discharge would be into the Pedernales River – Colorado River.	Water treatment plant wastes	1,000 gallons/day	n. d.	Turbidity less than 20 units	n. a.
Lakeway Inn and Marina	10631-02	Travis Co. – Lakeway Inn and Marina on Lake Travis, adjacent to Lohmann's Crossing Rd. •• Discharges into Lake Travis.	Water treatment plant effluent	4,000 gallons/week	4,000 gpd	Typical water treatment plant backwash & sludges	n. a.
Llano, City of	10209	Llano Co. – 701 Berry St., Llano •• Discharges into Llano River 200 ft. downstream from the Municipal Low Water Dam – Colorado River.	Water treatment plant wastewater	30,000 gallons/day (3 days a week); 380,000 gallons/month	0.023 mgd	Turbidity less than 20 units	TSS – 280 mg/l
Marble Falls WCID No. 1	10854	Burnet Co. – NE on point where U.S. Hwy. 281 crosses Lake Marble Falls •• Any discharge is to Lake Marble Falls.	Water treatment plant backwash water	17,500 gallons/day	n. a.	Turbidity less than 20 units	n. a.

TABLE V - 10A (Cont'd.)

Name	WCO Number	Location	Type of Wastewater	Effluent Volume[1]		Effluent Quality[1]	
				Permit	Present	Permit	Present
Neumann, Gene (Rivercrest Addition)	10713	Travis Co. – N end of Rivercrest Dr. in Rivercrest Addition on Lake Austin •• Discharge would be into Lake Austin.	Water treatment plant wastewater	10,000 gpm	n. a.	Turbidity less than 20 units	n. a.
Paradise Point Water Supply Corporation	10929	Llano Co. – At intersection of Lakeshore Dr. and Willow St. on W side of Paradise Point, Lake Buchanan •• No discharge.	Treated water treatment plant wastes	350 gpd; maximum of 2,500 gpd	n. a.	BOD – 1 mg/l [2] TSS – 20 mg/l [2]	n. a.
Robert Lee, City of	10803-01	Coke Co. – Near dam site of Mountain Creek Reservoir •• Any discharge will be into Mountain Creek – Colorado River.	Water treatment plant wastewater	90,000 gpd	n. d.	Turbidity less than 20 ppm	n. a.
San Angelo, City of	10841	Tom Green Co. – Near intersection of Metcalfe St. & East Ave. in San Angelo •• Discharges into Bell St. Lake – South Concho River – Concho River.	Backwash water and sludge	0.4 mgd of backwash water	0.182 mgd	Chemicals, sludge and backwash water	TSS – 211 mg/l
Sandy Mountain Development Co. (Sunrise Beach)	10752	Llano Co. – On the W shore of Lake Lyndon B. Johnson, Lot 651, Unit V, in Sunrise Beach 1 •• Discharges into Lake Lyndon B. Johnson.	Water treatment plant wastewater	72,000 gpd	0.025 mgd	Turbidity less than 20 units	n. a.
San Saba, City of	10887-03	San Saba Co. – in the Old Town Addition of San Saba •• Discharges into Mill Creek – San Saba River.	Water treatment plant wastewater	450,000 gpm	0.01 mgd	Turbidity less than 20 units	n. a.
Santa Anna, City of	10274-02	Coleman Co. – Approx. 2½ miles NE of Santa Anna at a site SE of Lake Sealy and N of Lake Santa Anna •• Discharge would be into Mud Creek – Jim Ned Creek – Lake Brownwood – Pecan Bayou – Colorado River.	Water treatment plant wastes	4,000 gpd	n. d.	Turbidity less than 20 units	n. a.
Snyder, City of	10056-02	Scurry Co. – T. N. Nunn Addition, City of Snyder •• Discharges into a tributary of Deep Creek – Deep Creek – Colorado River.	Water treatment plant effluent	15,220,000 gallons/year	0.153 mgd	Treatment chemicals, sediments and backwash water.	n. a.

[2]Values for wastes discharged to retention pond.

TABLE V-10A (Cont'd.)

Name	WCO Number	Location	Type of Wastewater	Effluent Volume[1]		Effluent Quality[1]	
				Permit	Present	Permit	Present
Talpa, City of	10750	Coleman Co. – S of the City of Talpa and on the public access road to City Lake ++ Any discharge will be into a ditch near the plant site – Grape Creek – Colorado River.	Water treatment plant wastewater	900 gallons/week	n. a.	Turbidity less than 20 units	n. a.
Travis Co. WC&ID No. 17	10468	Travis Co. – Approx. 2 miles SE of the Mouth of Hurst Creek ++ Discharge would be into Lake Travis.	Water treatment plant wastes	135,000 gallons/month	n. d.	Typical water treatment plant sludges and backwash water	n. a.
Winters, City of	10320	Runnels Co. – 600 ft. E of Jewel St. and 700 ft. N of State Hwy. 53 ++ Normally no discharge. Any discharge would be to Bluff Creek – Big Coyote Creek – Elm Creek – Colorado River.	Water treatment plant wastewater	30,000 gallons/day	n. d.	Turbidity less than 20 units	n. a.

Within the Basin, urban runoff reaches a receiving water by two primary avenues: an organized stormwater sewer system or as overland-type runoff. Since the avenue by which the runoff enters the stream can have such a notable effect on the stream, a survey was conducted to determine the nature of urban runoff throughout the Basin. This survey was conducted concurrently with the survey of existing wastewater treatment facilities. As seen in Table V-11 the survey indicated that 30 communities throughout the Basin have a defined stormwater sewer system. In the upper portion of the Basin very little, if any, of the runoff reaches the Colorado River or any of its principal tributaries. However, in the central and lower portions of the Basin, these storm-sewer systems may, and often do, discharge directly to the Colorado River.

Obviously, urban runoff is a reality in portions of the Basin. However, in general, with the exception of Austin, there are virtually no factual data regarding the quantity or quality of urban runoff within the Basin, nor its possible effect on the receiving watercourse. Even in the case of Austin, where a study of the receiving watercourse has been completed, there has not been a comprehensive study performed which would identify and quantify the urban runoff contaminant sources.

The primary reason for the interest in urban runoff in the Austin area has stemmed from the apparent degradation of the quality of the water in Town Lake, one of the City's primary water supplies. This degradation became increasingly obvious in the late 1960's. An indication of this degradation is shown in Figure V-I, which presents data on total coliform bacteria MPN/100 ml observed at the Albert R. Davis Water Treatment Plant intake just upstream from Tom Miller Dam (Lake Austin) and the Thomas C. Green Water Treatment Plant intake located in the upper part of Town Lake. As seen in Figure V-1 the monthly average number of total coliform bacteria ranged from near 3 to approximately 38 times higher in Town Lake than Lake Austin during the period indicated.

Upon review of the overall situation, the possibility of urban runoff causing, or at least contributing to the degradation of Town Lake was readily acknowledged. As seen in Plate V-6, in 1970 there were approximately 43 enclosed storm sewers, approximately 10 ditches, and approximately 8 creeks discharging runoff directly into Town Lake. Some of the enclosed storm sewers serve downtown Austin where runoff pollution can be expected to be high. Of these eight creeks, storm sewers discharge into Waller, Shoal, and Barton Creeks.

TABLE V-11

COMMUNITIES WITH STORM SEWER SYSTEMS

City	County	1970 Population
Andrews	Andrews	8,625
Austin	Travis	270,095
Ballinger*	Runnels	4,203
Bastrop	Colorado	3,112
Big Spring	Howard	48,264
Brady	McCulloch	5,557
Brownfield	Terry	9,647
Brownwood	Brown	17,368
Clyde*	Callahan	1,635
Coahoma	Howard	1,158
Coleman	Coleman	5,608
Colorado City*	Mitchell	5,227
Cross Plains*	Callahan	1,192
Denver City	Yoakum	4,133
Eagle Lake	Colorado	3,587
Elgin	Bastrop	3,832
Fayetteville	Fayette	400
Fredricksburg	Gillespie	5,326
Giddings	Lee	2,088
LaGrange	Fayette	3,092
Loraine*	Mitchell	700
Midland*	Midland	73,730
Miles*	Runnels	631
Odessa*	Ector	99,061
San Angelo*	Tom Green	73,402
Santa Anna	Coleman	1,310
Snyder	Scurry	11,171
Stanton*	Martin	2,117
Wharton	Wharton	7,880
Winters*	Runnels	2,907

*System consists primarily of open ditches.

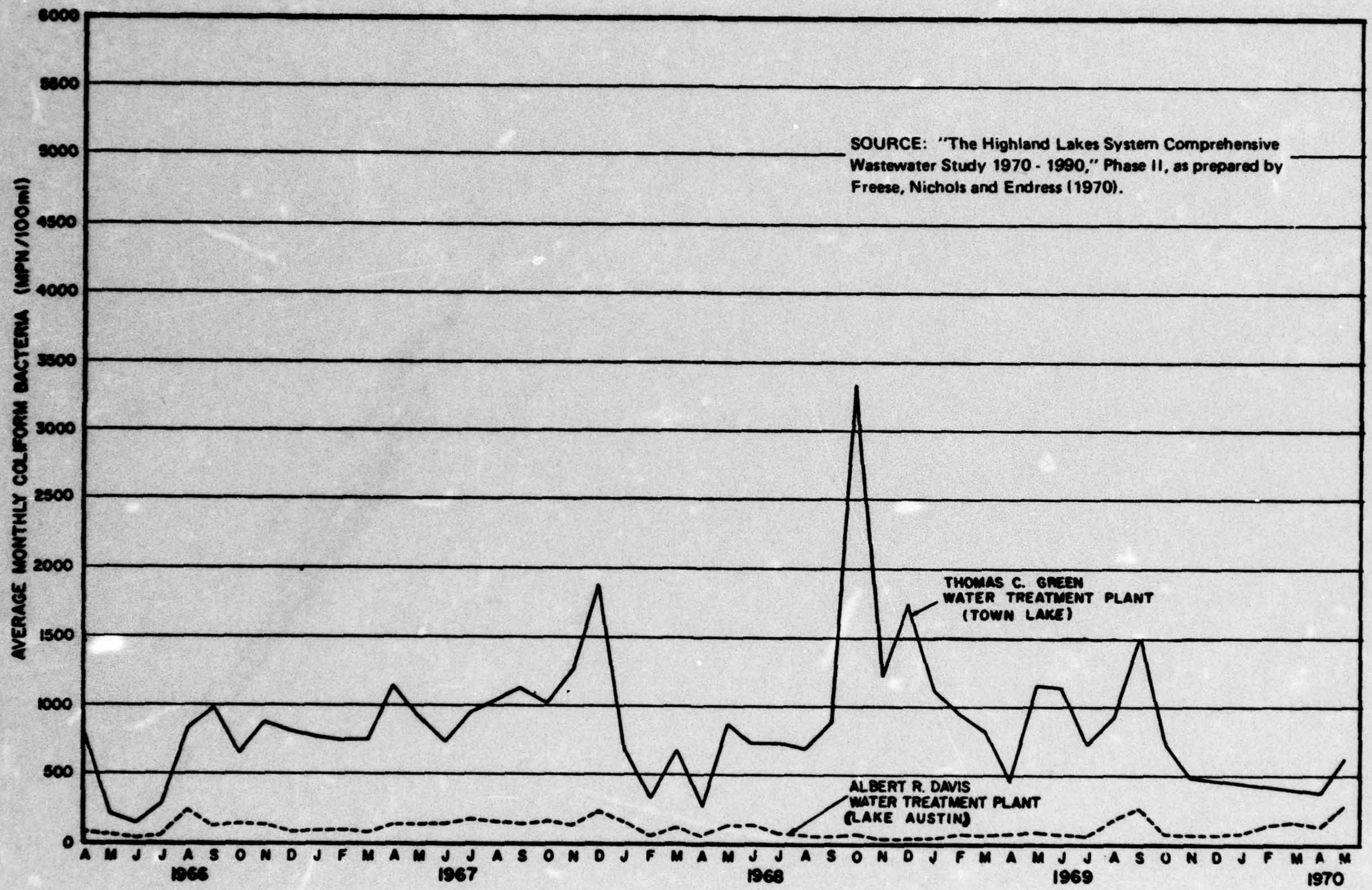
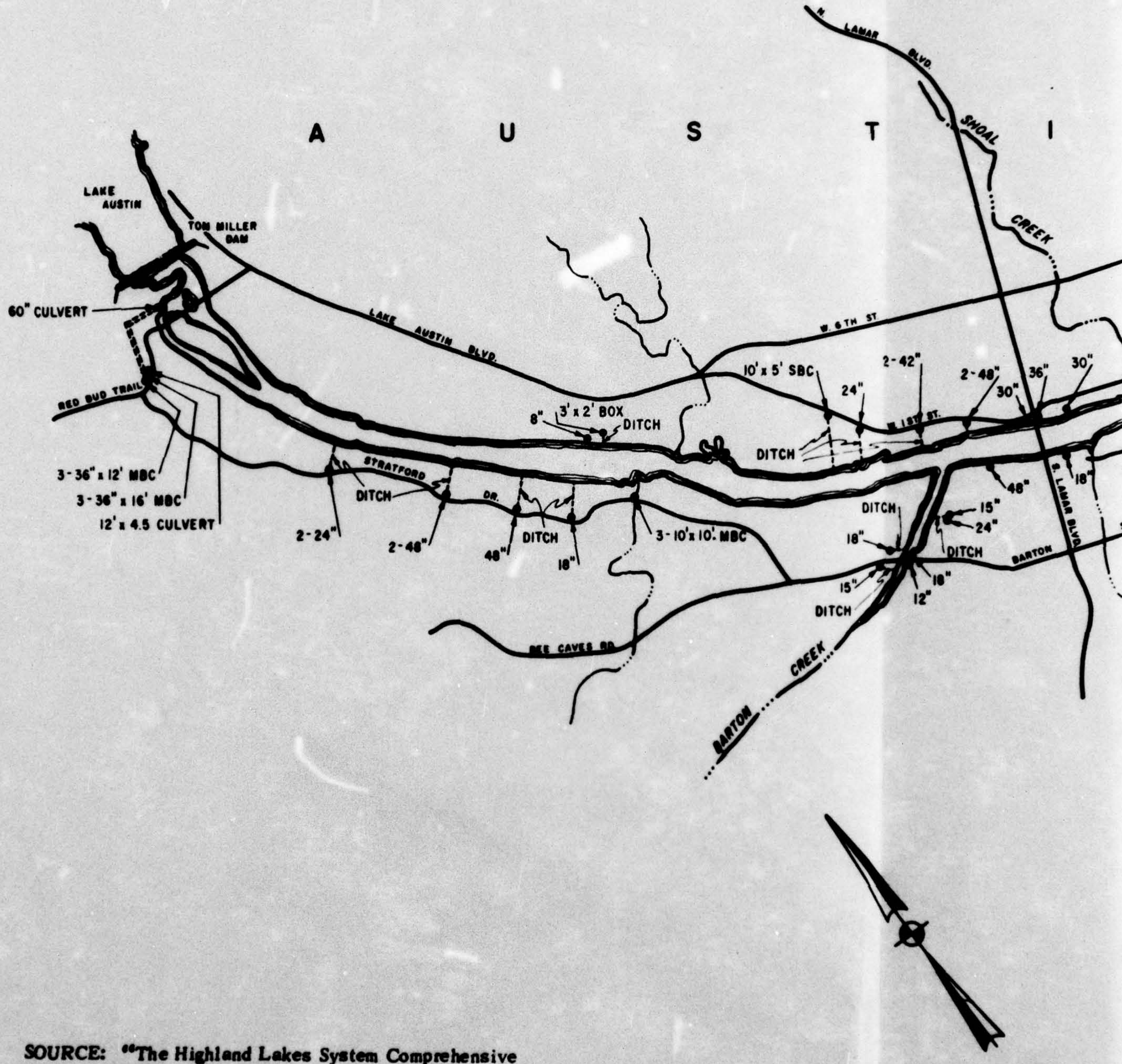


FIGURE V-1

TOTAL COLIFORM BACTERIA IN TOWN LAKE AND LAKE AUSTIN WATER



SOURCE: "The Highland Lakes System Comprehensive Wastewater Study 1970 - 1990," Phase II, as prepared by Freese, Nichols and Endress (1970).

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

STORM WATER OUTLETS INTO TOWN LAKE

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 2222' | PLATE No. V-6

2

Whereas it was not within the scope of this study to conduct a sampling program, there have been several previous studies which have witnessed the significant pollution potential on Town Lake of the runoff from Austin. One such study was conducted by Freese, Nichols and Endress in conjunction with the preparation of "The Highland Lakes System Comprehensive Wastewater Study 1970-1990." Results of samples taken of Waller Creek and Shoal Creek, whose combined drainage represents only about 53 percent of the Town Lake drainage area, vividly indicate the pollution potential of the urban runoff on Town Lake. A portion of the results of the study are presented in Table V-12. With regard to the runoff entering Town Lake, it obviously poses a threat to the quality of the lake, and some actions should be taken to alleviate this problem. It is therefore recommended that a comprehensive study be conducted to evaluate the effect of urban runoff on Town Lake and to present possible measures which should be taken to alleviate the problem in the next update of the State's Continuing Planning Process.

Concern has been expressed during the study regarding the possible detrimental effects of urban runoff from the City of San Angelo into the Concho River, a tributary of the Colorado River.

Within San Angelo, storm runoff flows directly into the North Concho River, which has been impounded several times in a park network through the city. Two concerns have been expressed: one, that the impoundments which are designed for public access, if not public bathing, may capture the contaminants of urban runoff and provide a contact area for persons who may use the impoundments for fishing or for bathing; two, that accelerated eutrophication due to runoff is occurring in the North Concho River below San Angelo.

The park areas which have been developed are dependent on runoff from a very limited area downstream from the San Angelo Lake. To collect, divert, and relocate the runoff from the urban area would deprive the park system of a large portion of its water supply and thus, at least, its aesthetic appeal. Therefore, abatement through this method would possibly have undesirable consequences.

A water sampling program should be undertaken to determine if a health hazard is developing in the water impoundments. If a problem occurs, steps should be taken to isolate and correct the source of pollution and, if possible, allow the remaining storm runoff to continue replenishing the impoundments.

TABLE V - 12

WATER QUALITY OF WALLER AND SHOAL CREEKS[1]

Waller Creek at First Street[2]

Date	7-1-70	7-1-70	7-2-70	7-15-70	7-15-70	8-3-70
Time	10:30 AM	3:40 PM	9:15 AM	10:30 AM	2:30 PM	10:00 AM
M.P.N., Fecal (100 ml)	33,000	17,200	23,000	23,000	330,000	31,000
M.P.N., Total (100 ml)	130,000	109,000	79,000	141,000	3,480,000	120,000
BOD_5, mg/l	7.0	8.0	3.5	1.0	50	10
COD, mg/l	30	25	<20	<20	540	30
Chloride, mg/l	98	99	98	98	17	105
Conductivity (micromhos)	765	760	790	780	218	810
Total S. Solids, mg/l	<10	12	<10	<10	2,304	<10
Turbidity, units	<25	<25	<25	<25		<25
Oil & Grease, mg/l	0		6	1	2	13
NH_3 - N, mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NO_3 - N, mg/l	<0.3	0.3	1.0	0.7	<0.3	1.0
T - PO_4, mg/l	0.10	0.66	0.96	2.40	4.70	2.46

Shoal Creek at Weir Near West 3rd Street

Date	4-3-70	4-8-70	4-9-70	5-15-70	7-1-70	7-1-70	7-2-70	7-15-70	7-15-70	7-15-70
Time	9:40 AM	3:45 PM	8:30 AM	11:00 AM	10:00 AM	3:15 PM	8:45 AM	9:45 AM	2:00 PM	2:05 PM
M.P.N., Fecal (100 ml)	33,000	13,000	23,000	172,000	23,000	23,000	63,000	330,000	330,000	330,000
M.P.N., Total (100 ml)	70,000	172,000	3,480,000	542,000	348,000	33,000	840,000	790,000	790,000	790,000
BOD_5, mg/l	11	30	8.5	27	5.0	19	20	35	105	120
COD, mg/l	<20			240	35	35	55	55	640	800
Chloride, mg/l	78			7	76	84	76	70	13	11
Conductivity (micromhos)	834			173	835	850	800	830	208	192
Total S. Solids, mg/l	11	62	16	292	<10	12	14	<10	945	1,853
Turbidity, units	<25	220	<25	350	<25	<25	<25	<25		
Oil & Grease, mg/l	17	4	10	5	0	4	6	1	1	0
Flow, cfs	.634	14.605	6.488		.634	.634	.634	.753	14.605	
NH_3 - N, mg/l	<1.0			<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
NO_3 - N, mg/l	1.0			<0.3	<0.3	1.0	0.8	0.7	<0.3	<0.3
T - PO_4, mg/l	0.26			1.7	0.31	0.76	0.19	7.20	7.70	9.40
Color		30	30							
PO_4								6.40	2.60	2.74
Boron								0.4	0.2	0.1

[1]*Source: "The Highland Lakes System Comprehensive Wastewater Study 1970-1990," Phase II, as prepared by Freese, Nichols and Endress (1970).*

[2]*No flow data presented.*

Non-Point Sources.

Agricultural Runoff and Irrigation Return Flow.

Agricultural runoff as used herein simply refers to overland type run-off from areas engaged in agricultural activity. Irrigation return flow, on the other hand, refers to the water diverted or withdrawn for irrigation use which is returned to or enters a receiving stream. Both agricultural runoff and irrigation return flows have been shown to have potential to cause water pollution. However, due to the areal extent and non-point nature of the two, control of these potential pollution sources is often cumbersome and, at best, feasible only in selected cases.

Agricultural runoff is a function of numerous factors such as soil conditions and the intensity and duration of rainfall. The pollution potential of the runoff is usually associated with the presence of one or more of the following:

1. Inorganic fertilizers, especially those with high nitrogen and/or phosphorous (PO_4) content.

2. Insecticides and herbicides.

3. Silt and other suspended solids.

4. Animal wastes (urine and manure).

Obviously, any one or all of the above would be expected to be present in an agricultural area.

The presence of the agricultural sector and its significance to the Basin economy has been noted. Agricultural pursuits occupy approximately 35 percent of the entire Basin area. In 1969, 14 percent of the Basin was actively engaged in farming. Although open-range grazing is still practiced, improved pasture management techniques have permitted a smaller acre-per-cattle ratio. In view of these conditions, it seems readily apparent the "pollution-causing" constituents are present, somewhat notably, in large portions of the Basin.

However, while the constituents are present, the carriage (runoff) is not always so abundant. As illustrated in Section 2, the climatology and physiography of the Basin are such that often little, if any, runoff occurs from large portions of the Basin which are engaged in agricultural activity. In fact, 25 percent of the Basin is considered hydraulically non-contributing.

Consequently, it is difficult, if not impossible, to evaluate the magnitude of agricultural runoff within the Colorado River Basin and its pollution potential. Suffice it to say that the potential is there, and that possibly some protection can be afforded by the application of sound land management techniques and conservation practices.

Whereas runoff is uncommon in large portions of the Basin, the practice of diversion or withdrawal of water for irrigation purposes is commonplace in the Basin. The irrigation return flow system, as illustrated in Figure V-2, is typical of that common to most river basins. The system is very complex, and may be repeated numerous times throughout the course of the river.

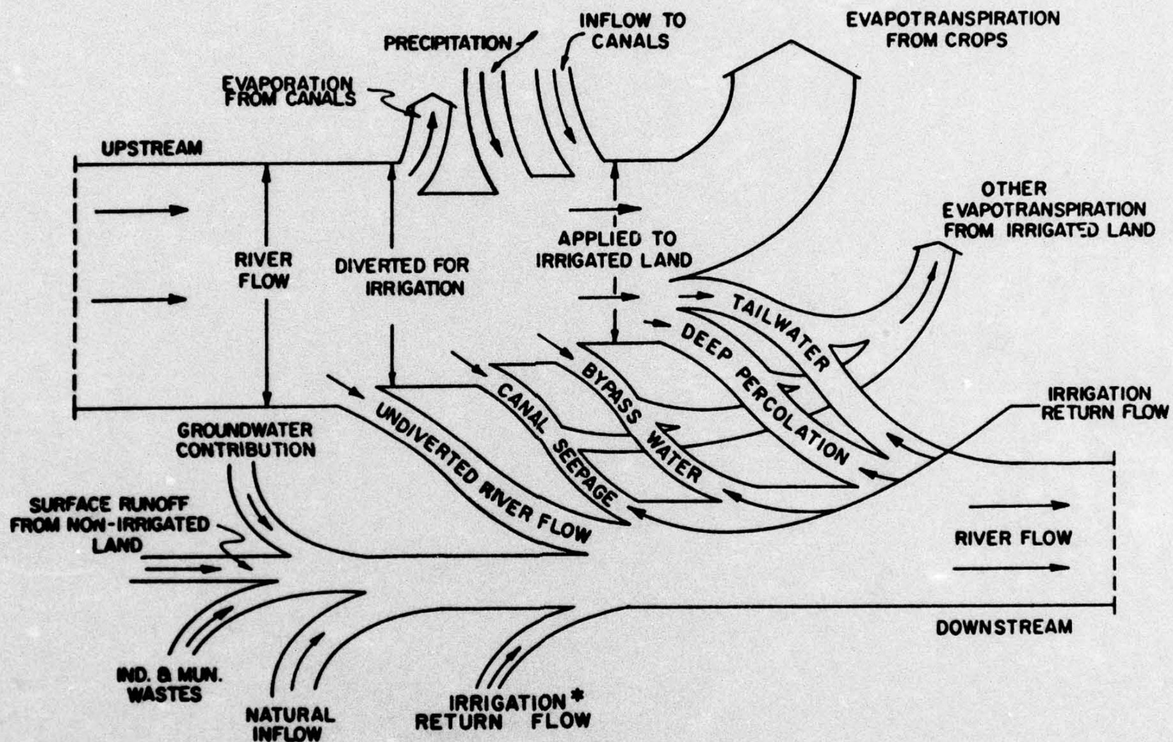
As seen in Figure V-2, return flow (bypass water), deep percolation (ground water flow), canal seepage, and tailwater (physical surface return flow) are the primary components of irrigation return flow. Bypass water is used to maintain hydraulic head and adequate flow through the canal system. It is usually returned to the river carrying very few additional pollutants. Canal seepage, on the other hand, contributes to high water tables, encourages phreatophyte growth, aggravates subsurface salinity, and generally increases saline drainage from irrigated areas. In many large projects, canal seepage represents a significant portion of the total diversion.

Tailwater and deep percolation are, respectively, the major contributors of irrigation return flow. Further, they are also the most probable avenues of pollution in the return flow system. Basically, the following changes over supply water can be seen in the two sources of return flow:

Tailwater	Deep Percolation
1. Slightly higher dissolved solids concentrations.	1. considerable increase in dissolved solids concentration.
2. Addition of variable and fluctuating amounts of pesticides	2. Variation in the total salt load.
3. Addition of fertilizer elements.	3. Little or no sediment or colloidal materials.
4. Increase in sediments and other colloidal materials.	4. Generally increased nitrate content.
5. Floating debris.	5. Little or no phosphorous content.

FIGURE V-2

MODEL OF THE IRRIGATION RETURN FLOW SYSTEM



*GROUNDWATER USED TO IRRIGATE

Tailwater (Con't)	Deep Percolation (Con't)
6. Increased bacterial content.	6. General reduction in oxidizable organic matter.
	7. Reduction in pathogenic organisms and coliform bacteria.

The constituents responsible for a pollution potential as well as the pollution mechanisms are obviously alluded to by the above listed changes.

Irrigation plays a significant role in the farming sector of the Basin. In fact, in 1969, approximately 661,330 acre-feet of water was used to irrigate a variety of crops on 894,252 acres, or 25 percent of the total Basin crop acreage. In view of the extensive use of irrigation in the Basin, it was imperative that some idea be obtained as to the amount and probable location of such return flows and their respective quality.

Although it was not within the scope of the study to develop detailed information on the return system, the amount of irrigation water returned to various streams was approximated. Such items as application rates, rainfall and evaporation, type of crop, size of tract, and type of soil were considered in the evaluation. The results of this analysis are presented in Table V-13 and Plate V-7, respectively. As shown in Plate V-13, return flow can be expected from only 14 of the 51 counties in the Basin in which irrigation is currently practiced. The total return flow from the 14 counties during 1969 was estimated as 40,647 acre-feet, or 33.7 percent of the total amount of water used for irrigation in the 14 counties that year. The return flow varied from a meager 86 acre-feet in Lampasas County to 13,644 acre-feet in Wharton County. The return flows were discharged primarily to the main stem of the Colorado River below Winchell, with lesser amounts to the Pedernales, Llano, and San Saba Rivers and Pecan Bayou. The amount of return flow (tailwater) is projected to increase such that in 2020, 36.5 percent (63,243 acre-feet) of the total amount of water used for irrigation in the 14-county area will be returned to the stream.

Due to the non-point nature of these agricultural sources, a truly comprehensive monitoring network would be required to evaluate what, if any, effect the return flows have on the streams. Currently, such a system does not exist, and the feasibility of such a network is questionable. Although there is a scarcity of pertinent data, the pesticide data collected

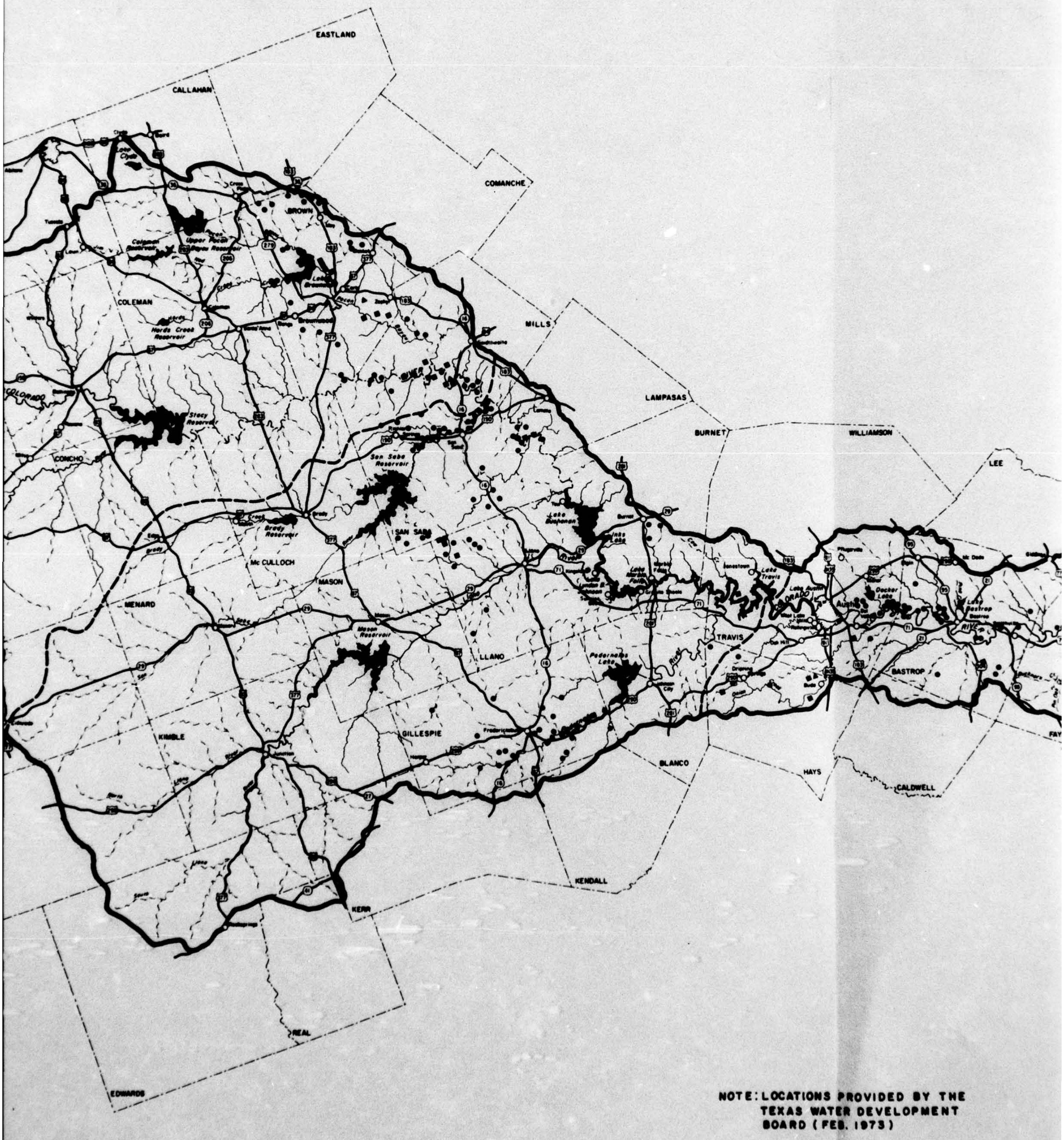
TABLE V-13

IRRIGATION RETURN FLOWS IN THE COLORADO RIVER BASIN[1]

(Units – Acre-feet)

County	1969	1980	1990	2020
Bastrop	305	710	1,124	1,863
Brown	3,728	3,118	2,562	2,562
Burnet	227	210	218	304
Colorado	9,653	9,716	9,771	9,623
Fayette	200	421	642	644
Gillespie	204	268	327	456
Hays	196	182	168	165
Lampasas	86	86	87	122
Llano	127	106	87	122
Matagorda	10,134	12,466	14,719	14,900
Mills	810	755	707	707
San Saba	996	1,418	1,802	1,862
Travis	337	606	881	881
Wharton	13,644	16,241	18,603	29,032
Total	40,647	46,303	51,698	63,243

[1] *Source: The Texas Water Development Board (Feb., 1973).*



NOTE: LOCATIONS PROVIDED BY THE TEXAS WATER DEVELOPMENT BOARD (FEB. 1973)

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S WATER DEVELOPMENT
D (FEB. 1973)

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

AREAS WHERE
IRRIGATION RETURN FLOWS
MAY BE EXPECTED

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 25 MI.	PLATE V-7

by the U.S.G.S. can possibly provide some insight as to the presence of wastewater from agricultural non-point sources and what, if any, effect it has on the receiving stream. The U.S.G.S. gathers this data at only three stations in the Basin:

Concho River near Paint Rock. Texas (081365)
Colorado River near San Saba, Texas (081470)
Colorado River at Wharton, Texas (081670)

These data are gathered periodically throughout the year, and the presence of ten insecticides (Aldrin, DDD, DDE, DDT, Dieldrin, Endrin, Heptachlor, Heptachlor epoxide, Lindane, and Chlordane) and three herbicides (2,4-d, 2,4,5-T, and Silvex) is determined. During water-years 1969 and 1970, trace amounts of various pesticides such as DDT and 2,4,5-T were found in certain samples. None of the concentrations appeared to be in what could be called toxic levels. It is again emphasized that these data are sketchy and, as such, should not be construed to reflect the absolute presence of nor the effect of wastewater from agricultural sources on the receiving stream.

Recently published data obtained from two irrigation return flow test sites in and adjacent to the Colorado River Basin in the coastal area operated by the Texas Water Development Board indicate "the concentration of constituents in both the applied and drainage waters are similar and of good quality for agricultural uses in both areas."

In view of the above discussion, it does appear that there is a significant pollution potential within the lower portion of the Basin from irrigation return flows. Further, these flows--especially tailwater--are projected to increase continually through 2020. Monitoring these flows is difficult; however, a monitoring program should be developed, as warranted, to evaluate the quantity and quality of tailwater and, if feasible, deep percolation. Once these data are available, schemes can be developed and implemented, as necessary, where needed to prohibit the discharge of "pollutants" to the receiving waters. Currently, several types of monitoring and treatment schemes for irrigation return flow are being evaluated in several of the larger basins in western states, and it is entirely possible that some of these schemes could be adopted for use in the Colorado River Basin. In conclusion, it should be noted that within the Basin there has been no known instance of water pollution by wastewater from either agricultural runoff or irrigation return flows.

Municipal Solid Waste Disposal Facilities.

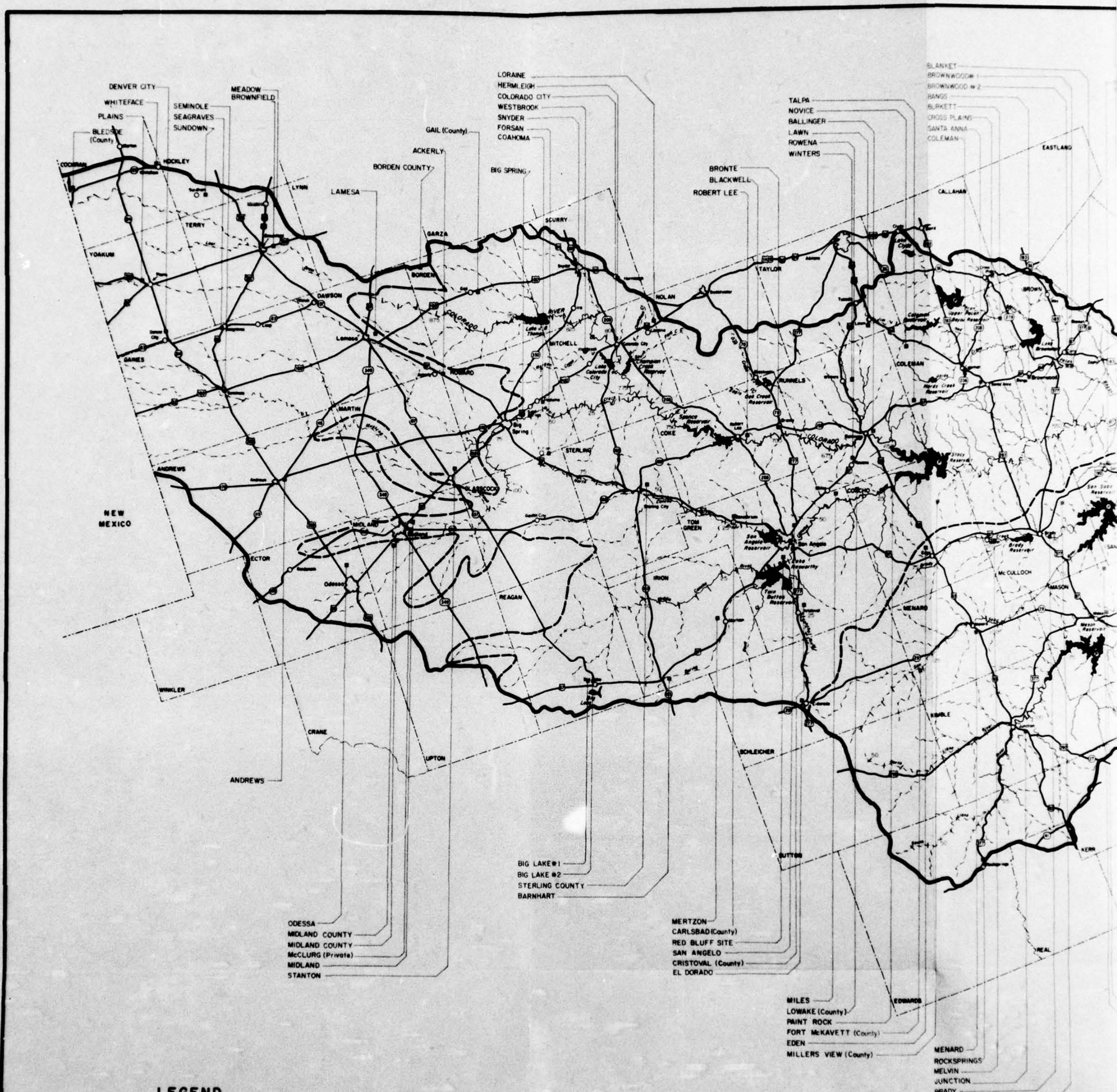
The disposal of the enormous volume of solid waste generated daily has become a major problem throughout the nation. The Texas State Department of Health (TSDH) has estimated that in Texas alone approximately 10.8 million tons of municipal solid waste were generated during 1970, almost double the amount generated in 1960. The volume represented an average per capita contribution of 0.967 tons per year. Applying this State-wide per capita value, it is estimated that approximately 0.8 million tons of municipal solid waste were generated in the Colorado River Basin during 1970.

According to numerous sources, the per capita contribution of municipal solid waste will experience a definite increase in the years ahead. Quite possibly some of the larger urban and metropolitan areas may resort to some other type of solid waste disposal, such as composting to dispose of the increasing volumes of waste. However, in the remainder of the Basin the relatively low operational cost of landfills and the ready availability of land should result in the continued use of landfills for disposal of municipal solid waste.

Surface runoff from an improperly operated disposal site can introduce large amounts of organic matter as well as undesirable chemical elements and pathogenic organisms to a stream. Through a somewhat more complex mechanism this runoff, or ponded water, can percolate through the underlying strata and pollute ground water reservoirs. Nitrates leached from the landfill operation pose the major threat to ground water contamination.

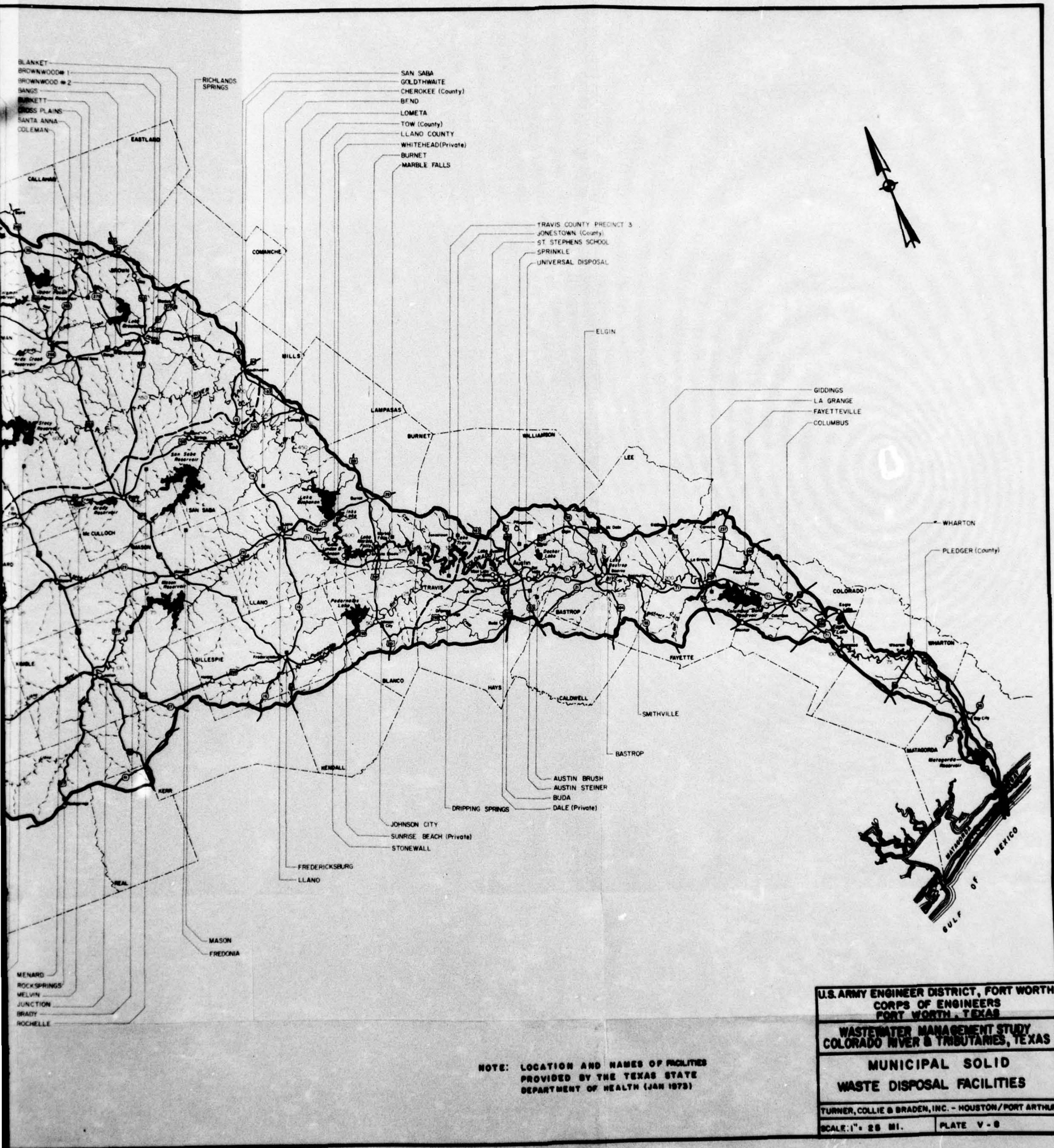
According to information furnished by the TSDH, there are currently 105 active, authorized municipal solid waste disposal facilities situated throughout the Basin (Plate V-8). These facilities may vary greatly in size, administrative arrangements, and degree of maintenance and operation. Fifteen of the sites are county facilities, while the remaining 90 sites are private or municipal disposal facilities.

A total of 18 solid waste disposal sites are located in the metropolitan areas within the Basin. All of these facilities have incorporated either embankments or natural slope to minimize runoff to and away from the disposal site. In Big Spring, Brownwood, Midland, Odessa, and San Angelo, the disposal sites are located over either heavy clays or caliche deposits which have very low permeabilities. The Austin landfills are situated in clay or silty clays.



LEGEND

■ MUNICIPAL SOLID WASTE DISPOSAL FACILITIES


BLANKET
BROWNWOOD #1
BROWNWOOD #2
BANGS
BURKETT
CROSS PLAINS
SANTA ANNA
COLEMAN
RICHLANDS SPRINGS
SAN SABA
GOLDTHWAITE
CHEROKEE (County)
BEND
LOMETA
TOW (County)
LLANO COUNTY
WHITEHEAD (Private)
BURNET
MARBLE FALLS
TRAVIS COUNTY PRECINCT 3
JONESTOWN (County)
ST. STEPHENS SCHOOL
SPRINKLE
UNIVERSAL DISPOSAL
ELGIN
GIDDINGS
LA GRANGE
FAYETTEVILLE
COLUMBUS
WHARTON
PLEDGER (County)
SMITHVILLE
BASTROP
AUSTIN BRUSH
AUSTIN STEINER
BUDA
DALE (Private)
DRIPPING SPRINGS
JOHNSON CITY
SUNRISE BEACH (Private)
STONEWALL
FREDERICKSBURG
LLANO
MASON
FREDONIA
MENARD
ROCKSPRINGS
MELVIN
JUNCTION
BRADY
ROCHELLE
EASTLAND
CALLAHAN
COMANCHE
BROWN
MILLS
LAMPASAS
BURNET
WILLIAMSON
LEE
SAN SABA
McCULLOCH
MASON
LLANO
TRAVIS
BASTROP
FAYETTE
COLORADO
WHARTON
MATAGORDA
GILLESPIE
BLANCO
HAYS
CALDWELL
KENDALL
KERR
KIMBLE
REAL
GULF OF MEXICO
NOTE: LOCATION AND NAMES OF FACILITIES PROVIDED BY THE TEXAS STATE DEPARTMENT OF HEALTH (JAN 1973)
U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS
WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS
MUNICIPAL SOLID
WASTE DISPOSAL FACILITIES
TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR
SCALE: 1" = 25 MI.
PLATE V-8

2

Very little data are available on landfills in the non-metropolitan areas. Even the data filed with the TSDH in the registration of the disposal facility are often sketchy. However, from what information that is available, it would appear that the situation in the Basin is similar to that reported by the TSDH in 1971. In surveying 860 landfills in the State, the TSHD found that only 124 were sanitary landfills--most of which were operated by larger cities--in the strictest sense of the term.

In this case, as in so many other wastewater sources, while the pollution potential is obvious, the lack of data prohibits an accurate evaluation of actual pollution at this time. The current effort by the TSDH to enforce the criteria outlined in the "Municipal Solid Waste Rules, Standards, and Regulations" should result in the compilation of the data necessary to assess the current condition of landfills in the Basin. These data can then be used to design a program whereby all inadequacies in existing landfills can be corrected, and their presence avoided in future sites. Such measures should all but eliminate the pollution potential of the landfill.

Individual Sewage Disposal Facilities.

Individual sewage disposal facilities include those serving residences, schools, camps, institutions, motels, and other places where municipal sewerage systems are not available. The three most common types of these facilities are the pit privy, the cesspool, and the septic tank. It is estimated that about 20 percent of the Basin population is served by some type of individual disposal facility. The most common of these facilities is the septic tank.

The septic tank system consists of a watertight tank and subsurface absorption field. It is relatively easy to construct and requires little operation or maintenance. Sewage discharged to the tank is retained as quiescent as possible for periods varying from 8 to 48 hours, dependent on the type of facility served. During this retention period, approximately 60 percent of the solids in the sewage settle out as sludge which accumulates in the bottom of the tank. The settled solids, as well as a portion of those solids in solution, are acted on by anaerobic bacteria. As more sewage enters the tank, it overflows into the subsurface absorption field. This field generally consists of concrete or clay pipe laid with open joints to allow the effluent to percolate into and through the soil. Remaining organic matter is removed by filtration through the soil and by aerobic bacteria which further stabilize the organic matter.

If properly designed and maintained, the septic tank system does provide acceptable treatment. When problems do occur, it is usually a result of inadequate subsurface absorption systems or a concentration of such systems.. In these instances, the sewage is not permitted to percolate properly, and thus moves laterally through the soil. Since the sewage discharged to the field still contains unstable organic matter and bacteria, it is imperative that the fields be designed to minimize the chances of contaminating any water supply. According to recommended data published by the Texas State Department of Health, a soil having a permeability less than one inch per hour is unsuitable for soil absorption systems.

As witnessed throughout the Basin, septic tanks have been and are being used by many small communities with acceptable results, and thus no public health hazards are created. However, in certain isolated instances, this method of disposal is no longer acceptable, and the city has had to construct wastewater collection and treatment facilities. One such example was the community of Ellinger with a population of about 200. The soil conditions were not conducive to extensive use of septic tanks. Consequently, in order to provide adequate waste disposal, the city constructed a wastewater collection and treatment system which a city of comparable size would not normally attempt to support.

Another area of intensive septic tank use is in those developments adjacent to lakes. One prime example is the Highland Lakes area where there are an estimated 10,000 such individual disposal systems in close proximity to the lakes. Proper operation of septic tanks in this area may be hindered not only by unsuitable soil conditions which exist around a large portion of the lakes, but by such a dense concentration of septic tanks that even suitable soils become overburdened with the amount of effluent. The end results of such condition is the eventual percolation of septic tank effluent to the lake.

Although no survey was conducted in conjunction with this study, previous reports have documented the apparent discharge of septic tank effluent to the Highland Lakes and Town Lake. According to these studies, the discharges have to date resulted in only localized problems with no wide-scale pollution of the lakes.

In an effort to provide some corrective measures, the TWQB has issued an order on each of the Highland Lakes regarding the construction of all wastewater treatment facilities and discharge therefrom within a specified proximity to each lake. The orders designate the LCRA as the Board's agent to perform both the administrative and licensing functions

of each order. In response to this designation, the LCRA had developed an inspection and licensing program and is currently actively involved in a program to abate pollution of the Highland Lakes by septic tanks.

Whereas there has been considerable study of the Highland Lakes and Town Lake, there has been very little if any detailed study on what effect septic tanks have had on the other reservoirs in the Basin. Several of these reservoirs, such as Lake Brownwood and E. V. Spence Reservoir, are important sources of municipal water supply and, as such, warrant special efforts to deter the degradation of these reservoirs. Although to date there has not been extensive development around these lakes, the potential is obviously there. Consequently, measures should be taken, as necessary, to protect against even localized contamination by discharges from individual sewage disposal systems or any other source.

Considering the above remarks, there are definitely locations within the Basin where water-resource contamination has resulted from improperly functioning septic tanks. In some instances, the problem could and has been corrected. It appears, however, that the primary constraint in correcting these problems is the cost. This is particularly exemplified by the cost of collection systems for lakefront developments. Although research is currently underway to develop efficient, economic methods to collect and treat domestic wastewater from areas such as noted above, the problem is such that some immediate efforts must be taken, as warranted, to prevent pollution hazards attendant to improperly functioning septic tank systems.

Non-Point Pollution Sources.

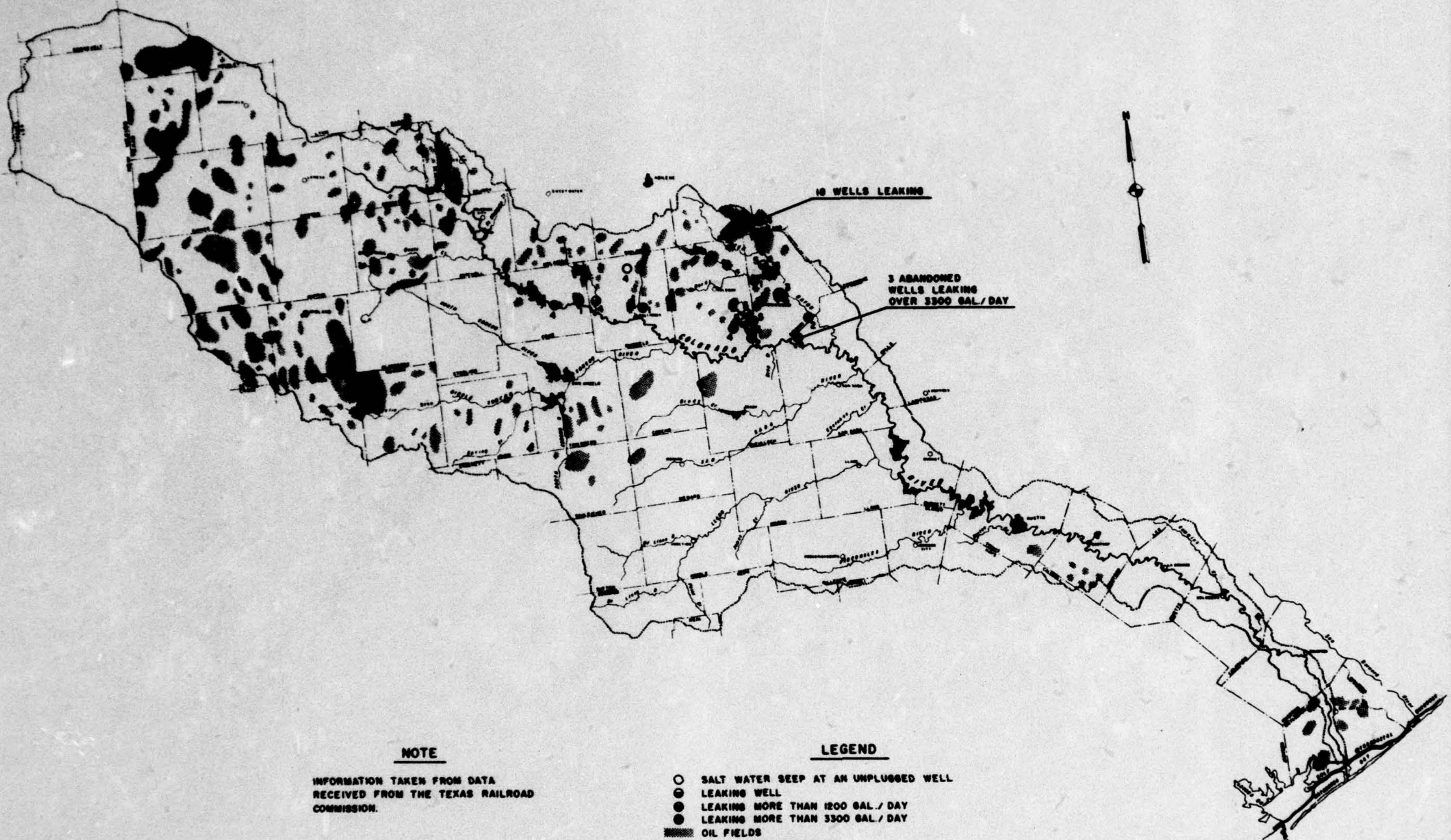
As detailed throughout this report, natural or non-point contamination of the fresh waters of the Colorado River Basin is a significant source of stream pollutants. Unfortunately, the distribution and magnitude of contamination associated with natural phenomena may place a limitation on the efforts of man toward total elimination of stream contamination. Without the technical or financial resources to eliminate natural runoff, levels of contamination associated with stormwater return flows and leaching from natural mineral deposits will remain the background or natural pollution level of the water resource. The U.S. Army Corps of Engineers has recently initiated a comprehensive investigation designated to locate and identify significant sources of natural salt contamination. The results of this investigation should be incorporated into the next update of the State's Continuing Planning Process.

Runoff, discharges, and seepage from areas of oil field activity, in conjunction with river contamination from natural mineral salt deposits, has evolved into the single most eminent water quality concern of residents in the Upper Basin. Substantial study beyond the scope of this Wastewater Management Study is necessary to begin to define the problem of salt contamination and locate the logical source, whether it be man-made or natural.

The general sources of salt contamination are well documented in other reports. During the compilation of this study, the natural background level of salt concentrations was taken by necessity as the baseline water quality condition. It is recommended the problem be given specific attention in a comprehensive study with adequate funding to actually identify sources and provide recommendations and cost estimates for alternative alleviation schemes. Since the effects of all salt contamination is essentially the same, the discussion of salt sources include both the natural contamination associated with mineral deposits and the man-made contamination associated with oil-field activity.

Oil is produced in many areas in the Colorado River Basin (See Plate V-9). Brine is produced in nearly all oil fields and it may, if improperly handled, eventually reach the streams. The composition of oil-field brine varies, but the principal chemical constituents in order of magnitude of their concentration are generally chloride, sodium, calcium and sulfate. The quality of the water in the Colorado River and Beals Creek in Mitchell, Howard and Scurry Counties is seriously affected by brines. Investigators in the past have disagreed as to the origin of the brine, but Reed(1) in a consulting report to the Colorado River Municipal Water District, presents convincing evidence that the brines entering the river are directly related to oil-field operations. The purpose of Reed's study was to determine the various sources of salt water present in the Colorado River, principally in the area between Lake J. B. Thomas and Colorado City--a distance of about 24 river miles. The study was divided into three parts: first, a detailed study of the geology of the upper 1,000 feet of section, with particular emphasis on the nature and structure of the surface beds which provide all the low flow of the Colorado River; second, a study of the ground water adjacent to the Colorado River and its tributaries, including chemical analyses and determinations of the altitude of the water table; and third, a study of U.S. Geological Survey quality and flow data of the Colorado River, together with measurements of the thickness of underflow gravel in the river channel. As a result of his study, Reed concluded:

1"Salt Water Pollution of the Colorado River, Scurry and Mitchell Counties, Texas," Colorado River Municipal Utility District, January 1961.



NOTE

INFORMATION TAKEN FROM DATA
RECEIVED FROM THE TEXAS RAILROAD
COMMISSION.

LEGEND

- ○ SALT WATER SEEP AT AN UNPLUGGED WELL
- LEAKING WELL
- LEAKING MORE THAN 1200 GAL./ DAY
- LEAKING MORE THAN 3300 GAL./ DAY
- OIL FIELDS
- SALT WATER SEEP AREA
- 1 APPROVED FOR PLUGGING
- 2 SUBMITTED FOR APPROVAL FOR PLUGGING WITH STATE FUNDS
- 3 UNDER LITIGATION
- 4 NO PLUGGING ACTION TAKEN
- 5 NO ACTION TAKEN

U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

**OIL AND GAS FIELDS
IN THE
COLORADO RIVER BASIN**

PLATE V-9

1. The probable maximum chloride ion concentration of the Colorado River prior to the development of the oil fields between the present site of Lake J. B. Thomas and Colorado City, Texas was on the order of 300 to 500 parts per million during periods of maximum evaporation.

2. There is no known source of natural inflow of salt water to the river with chlorides significantly higher than 500 parts per million.

3. A great percentage of the total mineral content of brines produced with oil in the watershed of the Colorado River does eventually find its way into the Colorado River itself.

4. There are an unknown number of abandoned oil wells which were improperly plugged and which are now contributing salt water to the Colorado River and which must be controlled.

Since the Reed study, all known abandoned oil wells which were polluting surface and ground waters have been plugged. There may be other abandoned wells which could be found only on intensive study of ground water hydraulics and quality. In addition, surface salt water disposal has been curtailed since 1969. In the study, Mr. Reed stated that it would take 12 to 15 years to observe any significant results of an abatement program. This is attributed to the large amounts of brine which have accumulated in ground water mounds under the disposal pits and around unplugged oil wells. These ground water mounds decrease in height slowly as the horizontal area affected increases, providing no new brine is added to the mound. The greatest movement is along the hydraulic gradient, towards the Colorado River.

Oil-field contamination of surface waters is not unique to the main stem of the Colorado River. Evidence exists that oil-field brines are causing some deterioration of water quality in the Concho River, Beals Creek and Pecan Bayou subbasins.

An indication of the magnitude of the man-made pollution problem is given by the tremendous volume of salt water produced with oil or gas in the area. The Texas Water Commission and Texas Water Pollution Control Board (1963) compiled an inventory conducted by the Railroad Commission of Texas which showed that approximately 222,400,000

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WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEX--ETC(U)

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barrels (28,680 acre-feet) of brine were produced in 1961 in the Colorado River Basin in Texas. Of this amount, 63.2 percent or 140,650,000 barrels (18,130 acre-feet), was reinjected into the subsurface, with the remaining 10,550 acre-feet being placed in unlined surface pits or dumped directly into surface watercourses. Some of the salt water reinjected into the subsurface also contributed to the problem because of inadequately completed injection wells and improperly plugged abandoned wells and test holes.

During the course of this study, all oil-field operations in the Colorado River Basin were surveyed by the Texas Railroad Commission. The results of the Commission's investigation were presented to the Governor's Planning Committee in letter-report form. That report is presented in Appendix D of the Basin Plan Appendixes, Volume 2. The extent of oil field contamination is under continuous study and investiation by the Commission. When a source of contamination is revealed, measures are taken to rectify the condition. It is recommended that the Commission continue its surveillance of the oil field operations of Texas and coordinate efforts with the Texas Water Quality Board.

VI. SEGMENTATION AND WASTE LOAD ALLOCATION

PL 92-500 has precipitated several interesting developments in the prescribed course of Basin water quality management planning. One of the more pronounced developments is the increased use and emphasis on segmentation. Under the Law, the segment--simply defined as any body of water, stream, reach or coastal area for which specific water quality standards have been delineated--appears to be the basic unit or level of the water quality management planning effort.

Section 303(e) of the Law requires the State to designate such segments, and classify them as to their compliance with the stream standards. Once this designation has been made, discharges are to be ranked within the segment and within the State--one list each for municipal and industrial discharges. Having established these priorities, or rankings, the maximum daily loading of a segment is evaluated, where necessary, and waste load allocations made, where required, to effect compliance with stream standards.

The purpose of this section is to delineate the above required information for the Colorado River Basin. A discussion of the methodologies used in developing the data is also presented below.

DESIGNATION OF SEGMENTS.

Incident to the enactment of PL 92-500 and subsequent implementation of the Law by the EPA, the TWQB has reevaluated their Water Quality Requirements of 1967. The results of this evaluation are presented in the "Proposed Water Quality Standards" dated April 1973.

These proposed standards present water quality criteria for 284 segments, as opposed to the 185 zones.(segments), delineated in the 1967 Water Quality Requirements. The large number of segments aptly indicates the spirit of the Law; that is, to identify segments on a level where realistic and effective remedial action can be taken to both abate and prevent pollution.

As shown in Table VI-1, and illustrated in Plate VI-1, 25 segments are delineated in the Colorado River Basin under the proposed standards. It is interesting to note that this is almost twice as many segments as were noted in the 1967 requirements. The primary reason for such an increase in the number of segments is that under the proposed standards,

TABLE VI - 1

SEGMENT DESIGNATION AND CLASSIFICATION[1] COLORADO RIVER BASIN

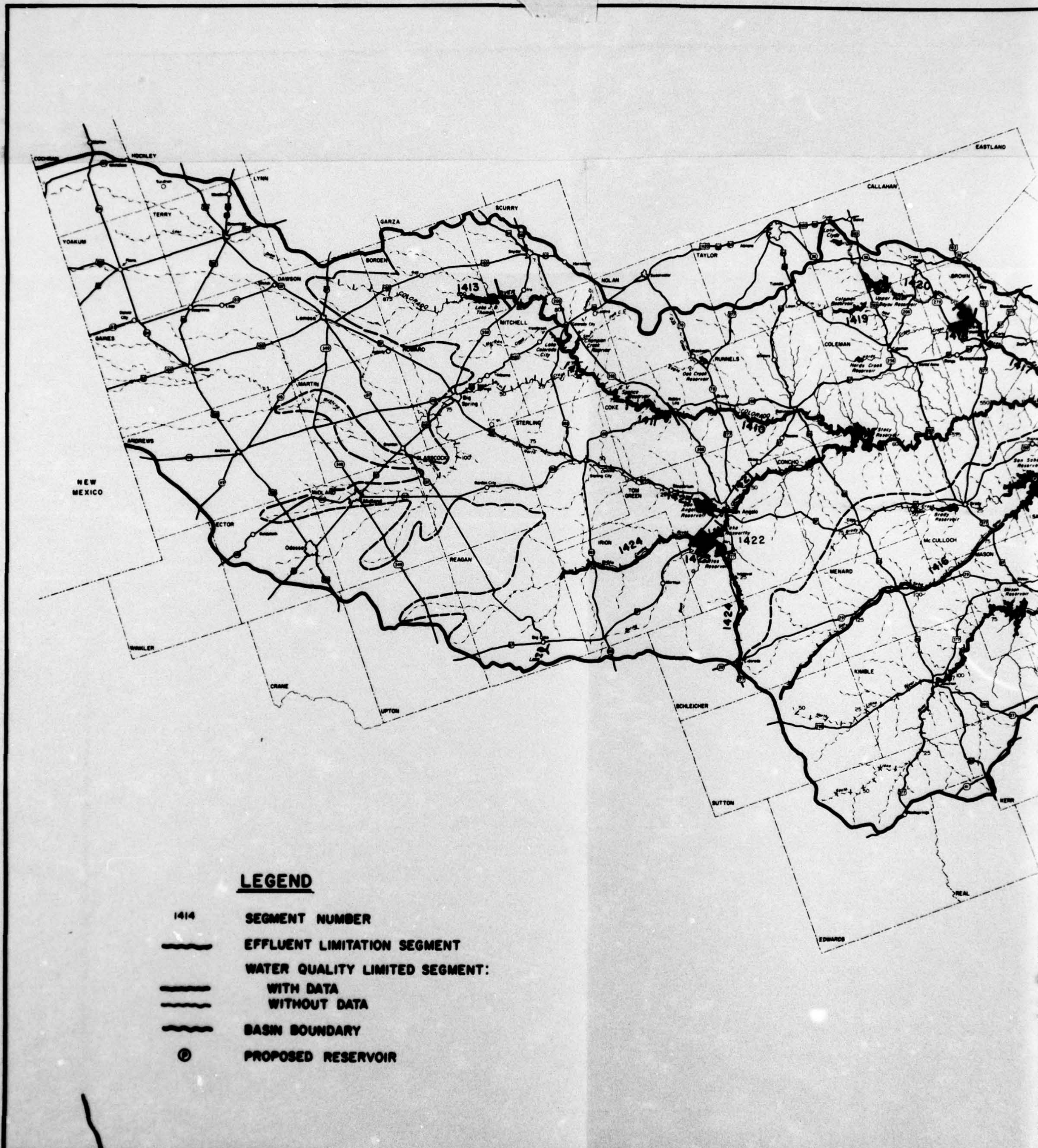
SEGMENT NO.	DESCRIPTION	APPROXIMATE LENGTH OF SEGMENT[2] (river miles)	CLASSIFICATION[4] W.Q.	E.L.
1401	Colorado River Tidal	22.8	X	
1402	Colorado River – above tidal to Tom Miller Dam, including Town Lake	274.8	X	
1403	Lake Austin	20.4	X[3]	
1404	Lake Travis	63.8	X[3]	
1405	Lake Marble Falls	6.2		X
1406	Lake Lyndon B. Johnson	21.4	X[3]	
1407	Inks Lake	4.2	X[3]	
1408	Lake Buchanan	17.4	X[3]	
1409	Colorado River – Lake Buchanan headwater to San Saba River confluence	48.8		X
1410	Colorado River – San Saba River confluence to E.V. Spence Reservoir (Robert Lee Dam)	236.3	X	
1411	E. V. Spence Reservoir	31.7		X
1412	Colorado River – FM 2059 near Silver to Lake J. B. Thomas (Colorado River Dam)	89.2	X	
1413	Lake J. B. Thomas	57.2	X	
1414	Pedernales River	123.2		X
1415	Llano River	110.62		X
1416	San Saba River	168.0		X
1417	Pecan Bayou – Colorado River confluence to Lake Brownwood Dam	57.0	X	
1418	Lake Brownwood	n.a.	X[3]	
1419	Lake Coleman	n.a.	X[3]	
1420	Pecan Bayou – above Lake Brownwood	n.a.	X[3]	
1421	Concho River – Colorado River confluence to fork in San Angelo, including South Fork to Lake Nasworthy Dam and North Fork to San Angelo Reservoir Dam	75.5		X
1422	Lake Nasworthy	6.1		X
1423	Twin Buttes Reservoir	17.6	X[3]	
1424	South and Middle Concho Rivers – above Twin Buttes Reservoir	73.8		X
1425	San Angelo Reservoir	13.7	X[3]	

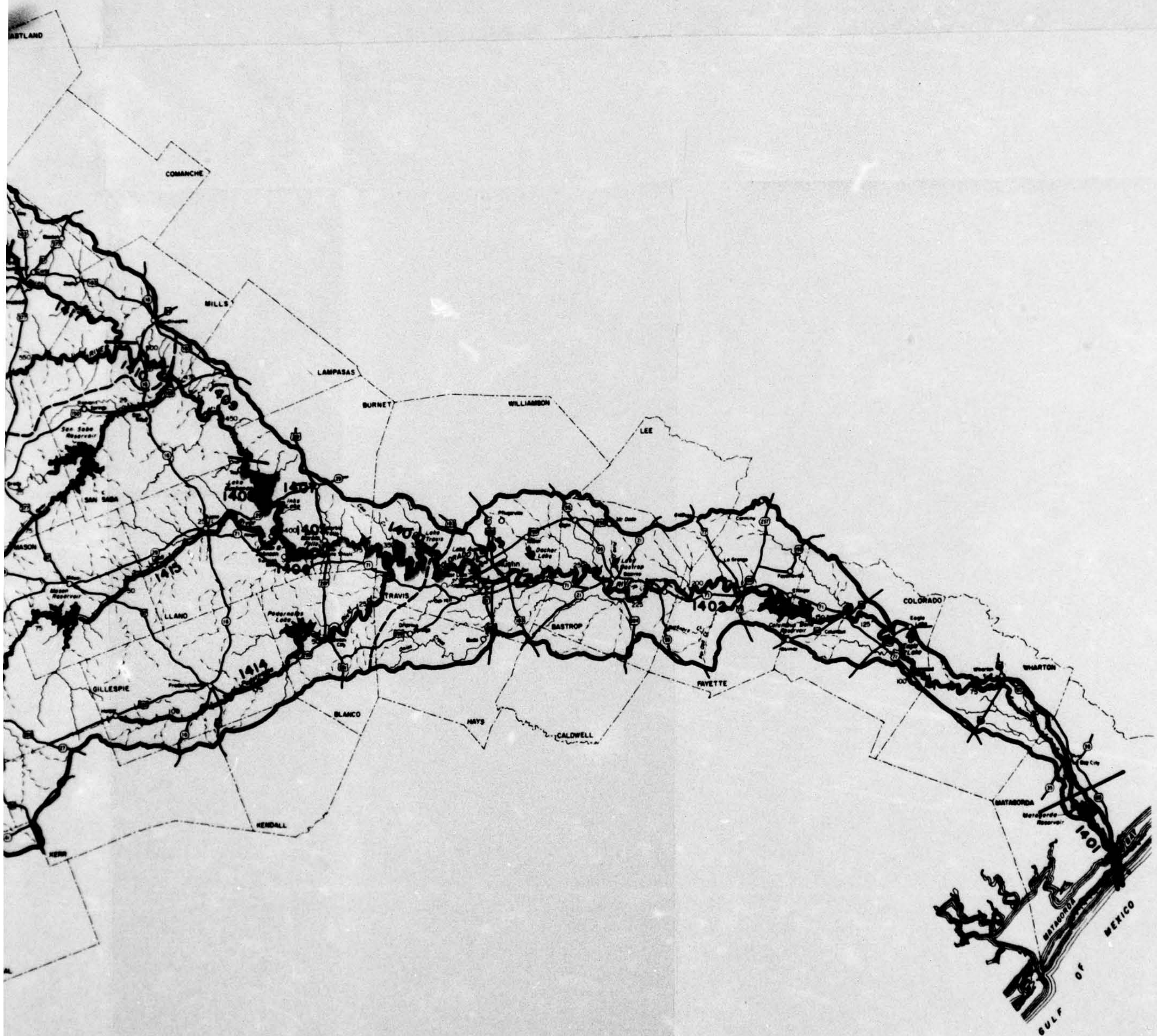
[1] *Provided by the Texas Water Quality Board.*

[2] *In the case of reservoirs, length refers to old river channel.*

[3] *So classified due to lack of sufficient data.*

[4] *W.Q.–Water Quality Limited; E.L.–Effluent Limitation.*


LEGEND
1414 SEGMENT NUMBER
EFFLUENT LIMITATION SEGMENT
WATER QUALITY LIMITED SEGMENT:
WITH DATA
WITHOUT DATA
BASIN BOUNDARY
PROPOSED RESERVOIR
NEW MEXICO
EASTLAND
CALLAHAN
TAYLOR
SCURRY
GARZA
LYNN
TERRY
YOAKUM
BORDEN
DAWSON
NOLAN
MITCHELL
COLEMAN
BROWN
RUNNELS
COKE
STERLING
MARTIN
ANDREWS
TOM GREEN
CONCHO
MENARD
Mc CULLOCH
MASON
KIMBLE
REAGAN
IRION
ECTOR
UPTON
CRANE
SCHLEICHER
SUTTON
EDWARDS
REAL
KERR
1413
1419
1420
1411
1410
1422
1424
1416



U.S. ARMY ENGINEER DISTRICT, FORT WORTH
CORPS OF ENGINEERS
FORT WORTH, TEXAS

WASTEWATER MANAGEMENT STUDY
COLORADO RIVER & TRIBUTARIES, TEXAS

SEGMENT DELINEATION
AND CLASSIFICATION

2

TURNER, COLLIE & BRADEN, INC. - HOUSTON/PORT ARTHUR

SCALE: 1" = 25 MI. PLATE VI-1

segment status has been afforded to thirteen reservoirs as opposed to one in 1967. Further, the tidal portion of the River has gained segment status.

CLASSIFICATION OF SEGMENTS.

Subsequent to the designation of the stream segments, the instream water quality of each segment was reviewed in light of the respective proposed standards for the segment. Upon completion of the evaluation, the segment was classified as being either effluent limitation or water quality limited. The distinction of the two classifications is as follows:

Effluent Limitation Segments-(1) the water quality does not exceed the proposed standards for the respective segment and will continue to be so with the application of "secondary" treatment for municipalities and best practicable control technology for industry; or (2) although the instream water quality currently violates the proposed standards, application of best practicable control technology for industry and "secondary" treatment for municipalities will result in compliance with the proposed standards.

Water Quality Limited Segment-(1) the instream water quality is currently in violation of the respective proposed standards and will continue to be so even with the application of best practicable technology for industry and "secondary" treatment by municipalities; (2) there is insufficient instream quality data to verify either compliance or violation of the proposed standards.

There are numerous significant water quality parameters which should be considered in determining the compliance of a stream with the proposed stream standards. However, in view of the urgent need to develop an initial classification system, only three basic yet significant "key" parameters--pH, total dissolved solids (TDS), and dissolved oxygen (DO)--were used in determining the compliance of the instream water quality with the respective proposed standards for the segment. In evaluating the data on the "key" or reference parameters, a violation was defined by the incidence of one or more of the following:

pH - one monthly value out of compliance.
TDS - the yearly average (the simple average of the monthly values) out of compliance.
DO - (1) a single monthly value out of compliance.
(2) the three-month moving average out of compliance.

While only three "key" parameters were evaluated, it is believed that they provide an adequate basis upon which to base the initial segment classification. Each of the three do reflect or indicate the pollution status of a stream. Further, the parameters are easily monitored and sufficient data were available upon which to make the initial determination. It should be noted that upon receipt of data from the soon-to-be expanded TWQB monitoring network, additional parameters will be evaluated in the segment classification revisions and update.

The primary source of data utilized in the analysis of the parameters was that obtained at TWQB monitoring stations throughout the State. There are 30 such TWQB monitoring stations (Plate IV-5) in the Colorado River Basin.

The TWQB field operations personnel collect samples at these stations monthly. Numerous field analyses are performed on-site and a portion of the sample is sent to the TWQB laboratory for further analysis. Basically, the analyses performed are:

<u>Field</u>	<u>Laboratory</u>
pH	pH
Conductivity	Conductivity
TDS	TDS
Temperature (^{o}F)	BOD_5
Chlorides	Chlorides
DO	Sulphates
Turbidity	Total Suspended Solids
	Volatile Suspended Solids
	Nitrogen (Total, NH_3, NO_3)
	Total Phosphate (PO_4)
	Chlorophyll
	Coliform (Total and fecal)

The field data for the "key" parameters were used in the determination of violation of the proposed stream standards.

Data used in the analysis were collected during water year 1972-- October 1, 1971 through September 30, 1972.

The end product of the classification procedure resulted in the segments within the Colorado River Basin classified as shown in Table VI-1. Of the 25 segments in the Basin, only 9 were classified as effluent limitation. In fact, with the exception of Beals Creek (which is not a specific segment) and Pecan Bayou, all of the principal tributaries are effluent limitation segments.

Ten of the sixteen water quality segments were so classified due to the lack of sufficient instream water quality data. Nine of these ten are reservoirs, and upon receipt of sufficient information it is very probable that these segments will be reclassified to effluent limitation. With the exception of segment 1413, Lake J. B. Thomas, all of the water quality segments in which violations were experienced are stream segments. The extent of these violations is as follows:

Segment 1401 (Colorado River Tidal) - Data gathered at TWQB Station 1414.29 (located on F.M. 521 bridge north of Matagorda--River Mile 15.9) reflected violation of both the pH and DO standards. The pH violation, 8.6, was recorded twice during the period. An unusually low DO level, 1.7 mg/l, was monitored in August 1972. This low DO level also resulted in the three-month moving DO average to dip below the DO standard of 5.0 mg/l.

Segment 1402 (above tidal to and including Town Lake) - pH violations were recorded at two of the four TWQB monitoring stations in the segment. Of the two violations, once each of 8.6 and 9.5, the 9.5 value was observed at TWQB Station 1401.34 south of Bastrop (River Mile 236.8). The pH of 8.6, 0.1 unit greater than the standard, was recorded southeast of Austin at River Mile 290.3 (TWQB Station 1401.7).

Segment 1410 (main stem from confluence with the San Saba River to E. V. Spence Reservoir) - The TDS standard of 1250 mg/l has been violated at least once at all three TWQB stations in this segment. However, the basis of the water quality classification for this segment was the yearly average of 1,500 mg/l recorded at the TWQB Station 1403.37 on U.S. Highway 277 south of Bronte (River Mile 695.3). This is the most upstream station in the segment. In general, the data collected at the other two TWQB stations (1403.12 and 1402.11) in the segment, downstream from 1403.37, reflected a general decrease in the yearly TDS concentration to 1,078 and 1,000 mg/l, respectively. Thus, there is a decrease of approximately 500 mg/l in the yearly TDS level in the 135-mile reach between the most upstream and downstream station in the segment.

Segment 1412 (F.M. 2059 near Silver to Lake J. B. Thomas) - There are two TWQB monitoring stations in this segment of the river. The standards violation was recorded at the most downstream station in the segment, TWQB Station 1403.32. In fact, the station is located on the extreme downstream end of the segment, the F.M. 2059 bridge near Silver. The violation, a DO level of 1.0 mg/l, was recorded at the

station in October, 1971. However, the DO levels monitored during the remainder of the year were such that there was no violation of the three-month moving average.

Segment 1413 (Lake J. B. Thomas) - Lake J. B. Thomas is the most upstream reservoir in the Colorado River Basin. There is only one TWQB station, 1405. 27, at the reservoir, just upstream from the dam. The basis of the water quality classification resulted from the violation of the pH standard, 8. 5, by a reading of only 8. 9. It is interesting to note that field pH value of 8. 9 varied notably from the pH of 7. 7 for the sample as measured in the laboratory.

Segment 1417 (Pecan Bayou from confluence with the Colorado River to Lake Brownwood Dam) - The DO standard was violated in this segment. Monthly DO violations were monitored at both TWQB stations (1400. 20 and 1400. 42) in the segment. Station 1400. 20 is located above the discharge of the main Brownwood wastewater treatment plant, and the DO level dropped below the standard of 5. 0 mg/l only once to 4. 5 mg/l. However, at the downstream station, which is located below all of the known dischargers in the segment, DO levels dropped to 3. 0 and 4. 0 mg/l in two consecutive months (August and September 1972). These violations caused the three-month moving average for the period July through September 1972 to be only 4. 0 mg/l at Station 1400. 42.

In summary, it is obvious that in general the violations recorded in the Basin are not extreme. The probable reasons for these violations are numerous and, in some cases, the reason is nothing more than conjecture. The possible reasons for these violations will be evaluated later in this section.

RANKING OF SEGMENTS.

Ranking of segments was the next integral step in the development of a Statewide segment ranking or priority list. This ranking of segments was based on noncompliance and the degree of noncompliance of instream water quality with the respective proposed standards for the segment. Noncompliance was based on a review of specific parameters. These parameters--pH, TDS, and DO--are the same as were used in the determination of segment classification.

The methodology used in ranking the segments was basically very simple. Initially, the parameters were weighted according to their Statewide effect on stream quality. Weights were as follows:

1	pH	-	one monthly value out of compliance.
2	TDS	-	the yearly average out of compliance.
4	DO	-	a single monthly value out of compliance.
8	DO	-	3-month moving average out of compliance.

The segments were then placed in twelve groups according to the type of parameter violated. Once these groups were compiled, the segments within each group were ranked according to the degree of violation of the stream standards. Water quality segments without data and effluent limitation segments were classified under one group. The ranking of the segments within this group was based on the relative magnitude of the quality and quantity of discharge within the segment with the total quality and quantity of all segments in the group.

While noncompliance was the primary consideration in the segment ranking, two other significant factors--the water use and population affected--were incorporated into the ranking of the segments within the groups. Finally, the Statewide ranking was obtained by weighing the various segments according to class. The class weights were "0" for Effluent Limitation segments, "1" for Water Quality (without data), and "2" for Water Quality (with data). A much more detailed discussion of the methodology and equations used is presented in Appendix E of the Basin Appendix.

As seen in Table VI-2, the 57-mile reach of Pecan Bayou from its confluence with the Colorado River to Lake Brownwood Dam (Segment 1417) is the top priority segment in the Colorado River Basin and the fifteenth ranked segment Statewide. Lake J. B. Thomas, the primary source of surface water in the upper portion of the Basin, ranks as the second highest priority in the Basin. Although the physical violation, a pH of 8.6, was not that large, thousands of people are dependent on this reservoir for their water supply for both municipal and industrial needs. Segment 1402, that reach of the Colorado River from tidal up to and including Town Lake, the most discharge-prone segment in the Basin, ranks third Basinwide. The tidal portion of the Colorado River ranks fourth within the Basin. The remainder of the classification is as would be expected.

With the exception of Segment 1417, the segments in the Basin are of relatively low priority statewide. This point is aptly shown upon review of the statewide ranking of the segments in the Basin. This relative ranking is not alarming in that the Colorado River Basin has not been known as one of the key pollution-prone basins in the State. However, its relative lack of pollution has not just resulted by chance, and continuing efforts must be expended to retard the presence of large scale pollution areas in the Basin.

TABLE VI - 2

RANKING OF SEGMENTS
COLORADO RIVER BASIN

SEGMENT NO.	DESCRIPTION	RANKING BASIN	RANKING STATE[1]
1417	Pecan Bayou – Colorado River confluence to Lake Brownwood Dam	1	15
1413	Lake J. B. Thomas	2	46
1402	Colorado River – above tidal to Tom Miller Dam, including Town Lake	3	56
1401	Colorado River Tidal	4	63
1412	Colorado River – FM 2059 near Silver to Lake J. B. Thomas (Colorado River Dam)	5	71
1420	Pecan Bayou – above Lake Brownwood	6	78
1410	Colorado River – San Saba River confluence to E. V. Spence Reservoir (Robert Lee Dam)	7	87
1404	Lake Travis	8	115
1403	Lake Austin	9	137
1408	Lake Buchanan	10	138
1407	Inks Lake	11	139
1406	Lake Lyndon B. Johnson	12	140
1419	Lake Coleman	13	144
1418	Lake Brownwood	14	145
1425	San Angelo Reservoir	15	146
1423	Twin Buttes Reservoir	16	147
1416	San Saba River	17	213
1415	Llano River	18	226
1405	Lake Marble Falls	19	240
1414	Pedernales River	20	249
1411	E. V. Spence Reservoir	21	265
1409	Colorado River – Lake Buchanan headwater to San Saba River confluence	22	266
1422	Lake Nasworthy	23	272
1424	South and Middle Concho Rivers – above Twin Buttes Reservoir	24	273
1421	Concho River – Colorado River confluence to fork in San Angelo, including South Fork to Lake Nasworthy Dam and North Fork to San Angelo Reservoir Dam	25	274

[1] *Source: TWQB computer printout entitled "Segment Ranking Report" dated May 14, 1973.*

RANKING OF DISCHARGERS.

Dischargers were initially ranked within their respective segment. Subsequent to the ranking within the segment, the dischargers were ranked Statewide. In both instances, two lists--one for municipal dischargers and one for industrial dischargers--were developed. Ranking of these dischargers was performed by the TWQB.

Ranking of dischargers within the segment was based on their respective magnitude of contribution of the discharge to the total load(s) discharged to the segment. BOD loading and BOD concentration were the primary parameters used to rank municipal dischargers. Industrial dischargers were ranked using the following parameters: BOD loading, BOD concentration, COD loading, COD concentration and pH. The proposed Statewide standards for BOD concentration (20 mg/l), COD concentration (150 mg/l) and pH (6.0-9.0) served as a base for the analysis. Actual effluent data used in the analysis were taken from Self-Reporting Data for the period March 1972-March 1973.

The ranking of the dischargers within the segments in the Colorado River Basin is shown in Table VI-3. The information presented in Table VI-3 is based on currently available Self-Reporting Data. Ranking of discharges from thermoelectric power generation operations was deferred pending receipt of additional guidelines.

While the Statewide discharger ranking lists could have been derived directly from the segment discharger ranking lists, it would not have reflected the actual stream conditions of the receiving segment. Consequently, the segment ranking and the discharger ranking values were integrated to obtain a Statewide discharge ranking that reflected both quality and quantity of the discharge as well as the stream conditions of the receiving segment. The methodology used in determining both the segment and Statewide discharger ranking lists is presented in Appendix F of the Basin Plan Appendix.

The respective Statewide ranking of municipal and industrial dischargers in the Colorado River Basin is shown in Table VI-4. As expected, the discharges from the metropolitan areas headed the municipal dischargers' list. Seven of the top ten Basin-ranked municipal dischargers discharge into Segment 1402, the third ranked segment in the Basin. The Brownwood Main Wastewater Treatment Plant, the lone ranked discharger in the top ranked segment in the Basin - 1417, ranks eleventh of the 37 municipal dischargers. The only industrial discharger ranked in the Basin is Celanese Chemical Company. On the Statewide level, Celanese ranked 235th out of the 371 industrial dischargers ranked.

In conclusion, the lack of data has prohibited the development of as comprehensive a discharger ranking as desired. Additional field data will be required to accurately evaluate the quantity and quality of the discharges. Upon receipt of this additional data, the lists will be updated and methodology refined as necessary.

MAXIMUM DAILY WASTE LOADS AND WASTE LOAD ALLOCATION.

Having determined the respective rankings for segments and discharges, a "plan of action" was developed to bring all non-compliant segments into compliance by 1977. Each of six Water Quality Limited (with data) segments was examined individually and a specific course of action developed for that segment. Since Effluent Limitation segments were currently in compliance, and by definition are projected to remain so during the next five years, no maximum daily load and incident waste load allocations analysis was required on these segments. Therefore, any discharge to an effluent segment must be in compliance with the national effluent guidelines as delineated in the Law. These guidelines are summarized as follows:

	Discharges From Respective Treatment Facilities	
Target Date	Public (Municipal)	Non-Public (Industrial)
1977	Minimum of Secondary treatment	Best practicable control Technology currently available
1983	Best practicable control technology	Best available technology economically feasible
1985	No discharge of pollutants	No discharge of pollutants

Until additional data are available on Water Quality Limited Segments (without data), discharges to these segments will have to be handled on an individual basis.

TABLE VI - 3

RANKING OF DISCHARGERS WITHIN SEGMENTS[1]

SEGMENT NUMBER	MUNICIPAL NAME	MUNICIPAL WCO NUMBER	INDUSTRIAL NAME	INDUSTRIAL WCO NUMBER
1401	No permitted discharges in segment.		1. CELANESE CHEMICAL CO.	00455-01
1402	1. AUSTIN (Govalle Plant)	10543-03	GIFFORD-HILL & CO., INC.[2]	01328-01
	2. COLUMBUS	10025-01	JOHN ROBERTS, INC.[2]	01258-01
	3. DEVELOPMENT ASSOC., INC.	11191-01	CAPITOL AGGREGATES, INC.[2]	00487-01
	4. AUSTIN-HORNSBY BEND PLANT	10543-04		
	5. ELGIN	10100-01		
	6. COLORADO CO. WC&ID No. 2 (Garwood)	10152-01		
	7. MANOR	11003-01		
	8. AUSTIN (Walnut Creek Plant)	10543-11		
	9. BASTROP	11076-01		
	10. GIDDINGS (South Plant)			
	11. WEIMAR	10311-01		
	12. LA GRANGE	10019-01		
	13. ELLINGER SEWER & WATER SUPPLY CORP.	10945-01		
	14. FAYETTEVILLE	10840-01		
	15. COUNTRY AIR, INC.	11040-01		
	16. SCENIC BROOK WEST, INC.	11021-01		
	17. GIDDINGS STATE BOYS SCHOOL	10456-03		
	WHARTON[2]	10381-01		
	SMITHVILLE[2]	10286-01		
1403	No known discharges in segment.		No permitted discharges in segment.	
1404	1. LAKEWAY MUD No. 1	10531-01	LONE STAR INDUSTRIES[2]	00641-01
1405	1. MARBLE FALLS WCID No. 1 (Marble Falls)	10654-02	No permitted discharges in segment.	
1406	No permitted discharges in segment.		No permitted discharges in segment.	
1407	No permitted discharges in segment.		SOUTHWESTERN GRAPHITE CO.[2]	00350-01
1408 & 1409	No permitted discharges in segments.		No permitted discharges in segments.	
1410	1. BALLINGER	10325-01	No permitted discharges in segment.	
	2. BANGS	10122-01		
	3. SANTA ANNA	10274-01		
	4. WINTERS	10320-01		
1411	No permitted discharges in segment.		No permitted discharges in segment.	
1412	1. MIDLAND (Main Plant)	10223-01	No permitted discharges in segment.	
	2. ODESSA	10238-01		
	3. BIG SPRING	10069-01		
	4. COLORADO CITY	10077-01		
	5. LORAINE	10430-01		
	6. SNYDER	10056-01		
	7. MIDLAND (Airport Plant)	10223-02		
1413	No permitted discharges in segment.		No permitted discharges in segment.	
1414	1. FREDERICKSBURG	10171-01	No permitted discharges in segment.	
1415	1. LLANO	10209-01	THE PACKS CORPORATION[2]	01391-01
	MASON[2]	10670-01		
1416	1. MENARD	10345-01	No permitted discharges in segment.	
	2. BRADY	10132-01		
1417	1. BROWNWOOD (Main Plant)	10565-01	ATCHISON, TOPEKA & SANTA FE RAILROAD YARD[2]	00739-01
	BROWNWOOD (Airport Plant)[2]	10565-02		
1418 & 1419	No permitted discharges in segments.		No permitted discharges in segments.	
1420	1. COLEMAN	10150-01	No permitted discharges in segment.	
	2. CLYDE	10148-01		
	CROSS PLAINS[2]	10434-01		
1421	MILES[2]	10138-01	No permitted discharges in segment.	
1422 – 1425	No permitted discharges in segments.		No permitted discharges in segments.	

[1] *Source: TWQB computer printout entitled "Discharger Ranking within Segment" dated May 15, 1973.*

[2] *Permitted dischargers, supposedly currently discharging, which were not ranked at this time due to insufficient Self-Reporting Data, no Self-Reporting Data, etc.*

TABLE VI - 4

BASIN AND STATEWIDE RANKING OF DISCHARGERS

NAME	WCO	SEGMENT NO.	RANKING BASIN	RANKING STATE[1]
MUNICIPAL				
MIDLAND, City of (Main Plant)	10223-01	1412	1	34
COLEMAN, City of	10150-01	1420	2	36
AUSTIN, City of (Govalle Plant)	10543-03	1402	3	39
ODESSA, City of	10238-01	1412	4	44
COLUMBUS, City of	10025-01	1402	5	56
AUSTIN, City of (Hornsby Bend Plant)	10543-04	1402	6	69
DEVELOPMENT ASSOCIATES, INC.	11191-01	1402	7	77
COLORADO CO. WCID No. 2 (Garwood)	10152-01	1402	8	113
ELGIN, City of	10100-01	1402	9	115
MANOR, City of	11003-01	1402	10	136
BROWNWOOD, City of (Main Plant)	10565-01	1417	11	161
BIG SPRING, City of	10069-01	1412	12	170
AUSTIN, City of (Walnut Creek Plant)	10543-11	1402	13	192
BASTROP, City of	11076-01	1402	14	193
GIDDINGS, City of (South Plant)	10456-02	1402	15	204
BALLINGER, City of	10325-01	1410	16	269
WEIMAR, City of	10311-01	1402	17	271
BANGS, City of	10122-01	1410	18	275
LA GRANGE, City of	10019-01	1402	19	289
COLORADO CITY, City of	10077-01	1412	20	340
SANTA ANNA, City of	10274-01	1410	21	349
LORAINE, City of	10430-01	1412	22	355
SNYDER, City of	10056-01	1412	23	412
CLYDE, City of	10149-01	1420	24	432
ELLINGER SEWER & WATER SUPPLY CORP.	10945-01	1402	25	452
FAYETTEVILLE, City of	10840-01	1402	26	466
WINTERS, City of	10320-01	1410	27	475
COUNTRY AIR, INC.	11040-01	1402	28	481
MIDLAND, City of (Airport Plant)	10223-02	1412	29	530
LAKEWAY MUD No. 1 (Inn & Marina)	10531-01	1404	30	609
SCENIC BROOK WEST, INC.	11021-01	1402	31	610
GIDDINGS STATE BOYS SCHOOL	10456-03	1402	32	664
MENARD, City of	10345-01	1416	33	760
LLANO, City of	10209-03	1415	34	962
BRADY, City of (Main Plant)	10132-01	1416	35	975
MARBLE FALLS WCID No. 1 (Marble Falls)	10654-02	1405	36	1018
FREDERICKSBURG, City of	10171-01	1414	37	1028
INDUSTRIAL				
CELANESE CHEMICAL COMPANY	00455-01	1401	1	235

[1] *Source: TWQB computer printout entitled "Statewide Ranking of Dischargers" dated May 15, 1973.*

In developing the course of action for a segment, the primary purpose was to develop a program aimed specifically at bringing the respective non-compliant parameter(s) into compliance. The procedure, performed for each non-compliant parameter utilized in the development of the program, consisted of the following three separate yet integrally associate steps:

1. Determine the minimum assimilative capacity of segment
2. Assess current loading conditions
3. Allocation of waste loads per discharge

There are numerous accepted ways or models that could be utilized in developing the program. In order to provide some common basis for those parties developing a "plan of action" for basins in the State, the TWQB has developed and distributed a methodology (calculation outline) for each of the following:

1. pH
2. Oxygen demanding materials (for use where DO violation were exhibited).
3. Conservative minerals - a conservative mineral being defined as one that is assumed to have no sources or sinks other than local inflows or diversions (for use where TDS violations were recorded)

Each of these methodologies basically presents a detailed version (along with appropriate formulas) of the three-step procedure above, relative to the specified parameter. A copy of each of the methodologies is presented in Appendix G of the Appendix. It should be emphasized that these outlines are tentative and they are subject to revision as deemed appropriate by the TWQB.

In application, there was not sufficient data available to permit an "allocation" with regard to pH. Consequently, it is recommended that pH "allocations" be deferred pending receipt of additional data, and that in the interim period the pH of all discharges into a segment shall not exceed the pH standard for the segment. The methodology for conservative minerals poses no major problem, providing adequate quality data are available.

Of the three methodologies, that for oxygen-demanding materials is the more involved. The outline provides for the approximation of three basic types of oxygen demand on the stream:

1. Natural oxygen demand - that loading entering the segment from the upstream segment.

2. Carbonaceous oxygen demand attendant with current dischargers to the segment.

3. Nitrogenous oxygen demand from attendant municipal discharges to the segment. This demand is usually considerably higher than that imposed by the carbonaceous oxygen demand.

In addition to the above current demand, allowances were made for any expected increases in the current loading during the next five years (through 1978). These current and projected oxygen demands were than compared with the assimilative capacity of the stream by the following equation:

Segment Target Load = AC-N-NO-P

Where AC = assimilative capacity

N = natural oxygen demand

NO = nitrogenous demand

P = projected increase in nitrogenous and carbonaceous demands over the next five years

(all units - ft^3 0_2/day)

The segment target load in effect represented reserve stream assimilative capacity available for carbonaceous BOD being discharged by existing facilities. If the existing daily load of carbonaceous BOD did not exceed the target load, no allocation was necessary,and thus stream standards could be maintained--at least during the next five years--by the discharge being in compliance with the national effluent guidelines.

With regard to the assimilative capacity of the segment for oxygen-demanding materials, it should be noted that this value is based on the minimum reaeration conditions, rather than the maximum. This procedure does yield conservative assimilative capacities, but it also provides a margin of safety which takes into account any lack of data from non-point source which inevitably cannot always be accounted for in the above analysis. Further, it is a more realistic approach than dedicating the maximum assimilative capacity of a stream to treatment of wastes.

The base effluent and stream quality data used in each methodology were then obtained from the TWQB Self-Reporting Data and Stream Monitoring Data, respectively. Segment characteristics, hydraulic and physical, were those gathered by the USGS at their network of gaging stations. The base flow used in the determination of the maximum daily loads and load allocations was the 7-day, 2-year low flow. This base flow is much less stringent than the original base flow for the entire study, the 7-day, 10-year low flow. The difference in these flows at selected stations is illustrated in Table III-1.

Results of the respective analyses, and the prescribed course of action for each segment are presented below. Appropriate supporting calculations (and assumptions) are presented in Appendix G, Volume 2.

Segment 1401 (Colorado River Tidal)

Dissolved oxygen and pH stream standards were violated in this segment of the river. The pH violations, only 0.1 unit above the maximum pH standard of 8.5, were in essence nominal. Efforts to identify the cause(s) of the pH violations were deterred by the lack of necessary data. As seen in the following discussion, it is highly probable that the violations could be attributed to a series of instances.

Initially, the segment could be expected to have somewhat of a high pH due to the tidal action and the subsequent mixing with sea water whose pH can range as high as 8.0-8.2[1]. Further, the waste entering the segment upstream from segment 1402 has, according to data collected at TWQB station No. 1401.3 at Wharton, had an average monthly pH of 8.2. In addition, the area drained by this segment is heavily farmed and, according to the TWQB, notable agricultural return flows can be expected. However, currently there is no program to either measure the quantity, quality or incidence of these return flows.

While there are numerous non-point type possible causes, there is only one known permitted discharge in the segment. Celanese Chemical Company (Waste Control Order No. 00455), which is located south of Bay City, discharged into the Colorado River (at river mile 22.5)at an average rate of 1.21 mgd during the period July 1971-June 1972. During this period of time, according to the respective Self-Reporting Data, the effluent was consistently in compliance with its permitted pH range of 6.0-9.5. However, several times during that period the reported maximum effluent pH value, although in compliance with the permit, exceeded the maximum proposed stream standard value of 8.5. Whereas this discharge cannot currently be identified as the cause of the violation, the possibility does exist.

In view of the above synopsis, the need for a plan of action is obvious. The following recommendations are presented in that regard:

1. Revise Celanese Chemical Company's Waste Control Order No. 00455, such that the permitted pH range is 6.5-8.5, the same as the proposed stream standards.

2. Investigate, as warranted, non-point sources, and any other pertinent conditions which could significantly alter the pH in this segment.

3. Upon completion of investigation take appropriate action where warranted.

The incidence of the violation of the DO standard posed the question of the stream's capability to assimilate the oxygen-demanding materials which were being discharged into it. Consequently, an analysis was performed to evaluate the assimilative capacity of the stream. The methodology used was that specified in the calculation outline for Oxygen Demanding Materials. Both a copy of the methodology and the respective support calculations are included in Appendix G of the Basin Appendix.

The assimilative capacity of the stream was calculated to be 1,191 lbs/day. The only discharger in the segment, Celanese, exerts a carbonaceous oxygen demand of about 81 lbs./day on the stream. Carbonaceous oxygen demand imposed on the segment from the upstream segment (1402) was estimated at 359 lbs/day. Since there is no projected increase in municipal or industrial discharges in the segment, the target load for the segment was established as 832 lbs/day. Upon comparison of the existing BOD_5 loading, 81 lbs/day with the segment target load, no waste load allocation for oxygen-demanding materials will be required in the segment during the next five years.

In conclusion, although the analysis indicates that there is sufficient assimilative capacity to prohibit a significantly low DO value of 1.7 mg/l as monitored at station 1414.29 north of Matagorda, the fact remains that it did occur. On the day the sample with the low DO was taken, the chlorides concentration was measured as 10,000 mg/l. This would indicate that there was notable saltwater intrusion. In such case, events could have occurred which could not be accounted for in the analysis utilized. While only a detailed field investigation could substantiate the cause of the violation, with the exception of the one violation, the monthly DO values monitored at TWQB Station No. 1414.29 averaged greater than 8.0 mg/l.

Segment 1402 (Colorado River tidal up to and including Town Lake in Austin)

The pH violations monitored in this segment range from the nominal 8.6 recorded southeast of Austin (river mile 290.3) to the 9.5 recorded south of Bastrop (river mile 236.8). As in the case of Segment 1401, the identification of the source(s) causing the violation was not possible. However, some pertinent observations should be made.

The segment is the most discharge-prone segment in the Basin. A total of 21 permitted wastewater facilities (not including water treatment plants or thermoelectric power plants), 18 municipal and 3 industrial, discharge an average of approximately 35 mgd to the segment. Of the permitted operations, the only apparent source of the violation is a ready-mix concrete batch plant. However, a review of the company's Self-Report Data showed that the company has reported no discharge from the facility during the period of record.

Although no comprehensive data are available on the quality of water being discharged from Town Lake, the study of the Highland Lakes by Freese, Nichols and Endress[2] in 1970 showed pH levels in Town Lake varying from 7.2 to 7.7, dependent on the sampling location. In general, pH levels increased from the headwaters to the dam. Therefore, it would appear that the water being discharged from Town Lake would not have a pH greater than 8.0 mg/l.

As noted in Section V, notable agricultural return flows could be expected in the segment; however, most of this would be expected in that portion of the segment downstream from Bastrop. Considering the presence of the rapids between Austin and Bastrop, any significant increase in the pH due to algal activity would be dampened by the reaeration afforded by the rapids. Another consideration is that a basic pH is often characteristic of streams which traverse limestone or other calcareous deposits which are evidenced in the Austin area. However, the stream does not traverse any such formations within this reach.

In view of the above facts, no conclusion could be reached as to the cause of the pH violations. While the violation southeast of Austin was nominal, the pH violation of 9.5 monitored at Bastrop merits serious consideration. Therefore, it is recommended that the TWQB conduct an investigation, as warranted, to determine the source(s) of "pollutants" causing these violations.

Although no DO violations were monitored in the segment, the possibility merited investigation, especially since an average of about 30.3 mgd of domestic wastewater is being discharged to the segment. In an effort to evaluate the situation, the mathematical model QUAL-1 [3] was applied to that portion of the river downstream from Longhorn Dam. The model was developed, verified, and applied by the Texas Water Development Board. The model was run under nine different loading conditions, utilizing the 7-day, 10-year low flow as the base flow in the stream. According to the model, the dissolved oxygen level would not be expected to dip below 5.0 mg/l anywhere in the reach, if the effluent limitations guidelines were adhered to. Therefore, such would be the case under the less stringent 7-day, 2-year low flow condition established by the TWQB as the low flow to be used in waste load allocations. A thorough discussion of the model, its application, the various loadings conditions evaluated and the respective results are presented in Appendix I of the Basin Appendix.

<u>Segment 1410</u> (Colorado River - San Saba River confluence to E. V. Spence Reservoir)

High total dissolved solids (TDS), primarily chlorides and sulfates, are not uncommon to this segment as evidenced by the data presented in Section IV.

Previously, one of the most significant, if not the most significant, sources of TDS was the inflow from the upstream segment. The magnitude of TDS from this source has been significantly reduced by the construction of the low-flow diversion structure (just upstream from the headwaters of E. V. Spence Reservoir), and the subsequent closure of Robert Lee Dam itself. The origin of the high TDS concentrations in the inflow has been contested; however, Reed [4] in 1961 presented convincing evidence that the brines entering the river are directly related to oil field operations. A recent survey [5] of oil and gas production leases in the Basin conducted by the Railroad Commission of Texas identified various operational violations in the adjacent oil fields as potential pollution sources.

In its report [5], the Railroad Commission of Texas also noted the presence of eight oil wells which were leaking brines within the immediate drainage area of the segment. Two of the wells(see Plate V-9) are located upstream from the TWQB station 1403.37, the station at which the TDS violation was evidenced. According to the report, there is slight flow from each well, and one is located on the bank of the Colorado River. Although there were no data submitted as to the volume or quality of the flow from these two wells, it is highly probable that either one or both of these wells are contributing sizeable TDS concentrations to the stream.

The presence of these well flows would be especially evidenced during periods of low flow, and, as seen in Section 2 of the 7-day, 10-year low flow, is zero in the upper portion of the segment.

In this analysis the target load, or maximum segment daily load, was calculated to be about 674 lbs./day. All of the permitted dischargers in the segment are from municipal wastewater treatment facilities. Since no data were available on the TDS concentration of these discharges, a value of 325 mg/l was assumed for use in the mass balance. Through a mass balance (excluding the contribution from the unplugged wells), the existing load in the stream was determined to be about 1463 lbs/day. Since the low flow at the upstream station is zero, no load was considered to be contributed by the upstream segment.

Normally, in cases where the existing load exceeds the target load, allocations are required; however, waste load allocations are not appropriate in this case for several reasons. Initially, all of the plants discharge below the most upstream TWQB monitoring station (1403.37) south of Bronte, where the yearly TDS violation was recorded. The average TDS concentration decreases 500 mg/l in that reach of the segment within which the discharges occur. Secondly, the typical secondary treatment process does not normally affect the concentration of the mineral constituent (the major constituent) of total dissolved solids at all. Lastly, flow in the upper portion of the segment is largely regulated by Robert Lee Dam. A review of the water quality in E. V. Spence Reservoir (as monitored at TWQB station 1404.13) revealed an average TDS concentration of only 557 mg/l.

Therefore, in view of the above facts, and the fact that there were no data available on the overflow from the two wells, it is recommended that any waste load allocation in this segment be deferred until such time that comprehensive data are available which will permit a more realistic evaluation of conditions in the segment.

<u>Segment 1412</u> (Colorado River - FM 2059 near Silver to Lake J.B. Thomas)

The DO violation, 1.0 mg/l, was monitored at the TWQB monitoring station (1403.32) at the downstream end of the segment. With the exception of this one value, the DO averaged 8.3 mg/l.

Analysis of the segment to determine the maximum daily loads and assimilative capacity was prohibited due to the fact that the 7-day, 2-year low flow throughout the segment is 0.0 cfs.

Although the analysis could not be performed, the water quality conditions in Beals Creek merit discussion. Beals Creek is the only principal tributary which has its confluence with the Colorado River in this segment. The confluence is at river mile 769.8, about 22 miles upstream from TWQB station 1403.32. Three of the five "significant discharges" ranked in the segment are located in the drainage area of Beals Creek. And of these three, the only physical discharge which could affect the segment is that from the Big Spring municipal wastewater treatment facility.

There are two plants (on the same site) at Big Spring; however, only the main plant discharges. According to the Self-Reporting Data, the plant discharges to Beals Creek at an average rate of about 2.35 mgd. The simple average of the Data reflects an effluent BOD_5 of 21 mg/l and TSS of 22 mg/l, as compared to the permitted 20-20 effluent criteria. Since Beals Creek is predominately a dry creek upstream from the plant discharge, the streamflow below the plant is effluent dominated.

The TWQB stream monitoring station (1400.26) is located on F.M. 821 bridge, which is approximately 24 miles downstream from the point of discharge from the Big Spring plant. As noted in Section 4, data collected at the station over a several year period reflect a 70 percent probability that the BOD_5 will be equal to or greater than 5.0 mg/l. The data also indicate a 32 percent probability that the DO will equal or be less than 5.0 mg/l.

The pollution potential is present; however, what effect it has on the Colorado River, about 68 miles downstream, is not known at present. This relation may be explored as warranted in future studies. The above facts vividly indicate that Beals Creek does merit "looking at" in future revision of water quality standards, and possible coverage by an extension of the downstream stream standards.

Segment 1413 (Lake J. B. Thomas)

Lake J. B. Thomas is one of the two primary sources of surface water in the upper portion of the Basin. Genuine efforts are taken to prohibit the pollution or any degradation of this lake.

The lake is sustained primarily from storm runoff. There are no known municipal or industrial discharges to the Lake proper or any of its tributary streams. There is no known agricultural return flow to the lake. Degradation of the lake by attendant septic tanks poses no imminent problems, as the area adjacent to the lake is sparsely settled.

Data indicate that the water in the lake is generally of good quality. Excluding the single pH value, 8.9 in violation of the proposed standards, the lake water has an average pH of 7.7. The violation, which was nominal - 0.4 unit, was not necessarily characteristic of the lake water. In view of the above circumstances the noncompliant pH value was caused by some natural occurrence such as photosynthesis. The water quality of the lake should continue to be monitored, and should the occurrence of noncompliant pH or any other parameter increase, appropriate measures should be taken to identify the source of the problem and provide prompt corrective action.

Segment 1417 (Pecan Bayou - Colorado River confluence to Lake Brownwood Dam)

As seen in Table VI-2, this segment is ranked first in the Basin and 15th in the State. There are only three known discharges to the segment--the two City of Brownwood wastewater treatment plants, and the Atchison, Topeka, and Santa Fe railyards. All of the three discharge into the upper 17 miles of the Bayou. The City of Brownwood's main treatment plant with an average daily flow of 2.2 mgd comprises more than 99 percent of the total return flows discharged to the stream by the three facilities.

The fact that there were violations of the dissolved oxygen standard, 5.0 mg/l, is understandable when one considers that approximately 99 percent of the streamflow, 3.4 cfs of the 3.5 cfs., downstream from the main Brownwood plant discharge point is effluent. Several miles downstream (TWQB station 1400.42) from the discharge point the DO level has remained above 3.0 mg/l.

During low flow conditions the stream is dominated by treated sewage effluent. In such cases, the proposed standards provide for a minimum dissolved oxygen concentration of 2.0 mg/l; in the analysis a DO standard of 5.0 mg/l was used.

The assimilative capacity of the stream was calculated to be 509 lbs/day. The loadings on the stream were calculated to be as follows:

1. Natural Oxygen Demand = 0 lbs/day
2. Significant Existing Discharges to Segment:

Brownwood Main Plant -
Carbonaceous Oxygen Demand - 398 lbs/day
Nitrogenous Oxygen Demand - 660 lbs/day

3. Projected Five-year Increase in Discharge:

Municipal

Brownwood Main Plant -
Carbonaceous Oxygen Demand - 7 lbs/day
Nitrogenous Oxygen Demand - 13 lbs/day

Industrial

None

The target load of the segment was calculated to be a negative 180 lbs/day. Thus, there is a deficit in stream assimilative capacity, which indicates that no stream assimilative capacity is available for discharge of carbonaceous oxygen-demanding materials. Instead of performing a wasteload allocation, dischargers within the segment will go to "no discharge" or as allocation equivalent to 0 (zero) lbs/day.

GENERAL SUMMARY

In review, only six of the twenty-five segments in the Basin were classified water quality segments. Three of the segments were out of compliance, due totally or partially to a pH standard violation. Insufficient data prohibited identification of the source(s) causing the violation. Additional data should be collected, as warranted, to isolate the source. Only one of the six segments was out due to a TDS violation, and the analysis reflected that no allocation is appropriate at this time. Lastly, DO violations were recorded in three segments. Analysis performed on one of the segments indicated that no allocation would be required to meet the stream standards. The low flow condition in another segment was zero, consequently, no analysis was performed. In the third segment, dischargers were required to go to "no discharge" or an allocation of zero lbs/day. The above conclusions reinforce the fact that the Colorado River Basin is basically a fairly pollution-free Basin.

REFERENCES

1. Brahtz, John F., Ocean Engineering, Wiley, New York, New York (1968).

2. "The Highland Lakes System Comprehensive Wastewater Study 1970-1990," prepared for the Lower Colorado River Authority and City of Austin by Freese, Nichols, and Endress, Consulting Engineers, January, 1971.

3. Texas Water Development Board, "Simulation of Water Quality in Streams and Canals," Report 128, May 1971.

4. Reed, Ed L., "A Study of Water Pollution of the Colorado River Scurry and Mitchell Counties," report to Colorado River Municipal Water District, January 1961.

5. Railroad Commission of Texas, Oil and Gas Division, "Summary of Railroad Commission's Investigation of Oil and Gas Producing Leases in the Colorado River Basin," July 1972.

VII. BASIN ALTERNATIVES

Alternative Discussion and Evaluation.

The purpose of this section of the report is to present and evaluate the feasibility of a number of alternative methods for meeting the water quality objectives of the study. The alternatives to be considered were originally developed to meet January 1971 Environmental Protection Agency "Guidelines-Water Quality Management Planning." However, during the course of this study, P. L. 92-500 was enacted to bring about an entirely new concept across the nation to eliminate all pollution of the nation's waters. Even though some of the alternatives will not meet the intent of the new law, a discussion is provided. The alternatives considered herein are listed below, and are followed by a discussion of each as related to the Colorado River Basin.

A. Treatment
B. Relocation of Discharge
C. Diversion from Basin
D. Flow Regulation (Augmentation)
E. In-Stream Modification
F. Water Re-use
G. Control of Wastewater Quantities by Zoning and/or Planning Growth
H. Combinations of the Above

A. Treatment

Upgrading waste streams is the first and most important alternative which should be considered in meeting water quality objectives. In evaluating this alternative, the following points must be considered:

1. To what degree would waste streams need to be upgraded to achieve tangible results?

2. What would this cost, especially with respect to another alternative?

3. Will upgrading waste streams permanently solve the problem?

In answering the first point, there are several ways to accomplish this task. The first answer lies in water quality standards established by the Texas Water Quality Board which are numerical criteria applicable to all surface waters for which standards are established. In arriving at these standards, generally the suitability of the waters of the State for various uses were determined, including contact and noncontact recreation, domestic raw water supply, irrigation waters, and shellfish waters. Numerical values in the water quality standards are determined by analysis of sampling data.

A second method of determining the level of treatment necessary is by mathematical modeling of a stream. In modeling a stream, many assumptions must be made regarding flow conditions in the stream, physical characteristics of the stream, volumes of wastewater effluent and quality of the effluent. Thus, the effects of many variables may be studied by a trial-and-error method until the desired set of circumstances is reflected. By utilizing this method, it can be indicated whether or not upgrading waste streams would solve the problem. It is possible that a stream may reach a degraded condition under certain circumstances whether the wastewater effluent is present or not. It must be realized, however, that modeling a stream in this manner can only give an indication of what probably will occur. A stream is a very complex system, and its physical and chemical nature is influenced by many factors.

The final consideration in determining the level of treatment for upgrading wastewater streams in the Colorado River Basin is the Federal Water Pollution Control Act Amendments of 1972. The Act calls for specific levels of treatment by a certain date in the nationwide effort to eliminate water pollution. At this time, the degree of treatment representing the various levels of treatment are not clearly defined, especially with respect to numerical values or parameters of effluent quality constituents. For the purpose of this report, a rationale for phased implementation of the Amendments was developed with respect to what constitutes various levels of treatment by certain dates.

The treatment alternative is already implemented throughout the State of Texas to a degree of at least secondary levels. The secondary level of treatment does not meet the intent of P. L. 92-500 for "best practicable" by 1983 or "no discharge of pollutants" by 1985, but it does provide a basis on which to build in progressing toward the goals of P. L. 92-500.

Treatment of waste is expensive in terms of dollars, but there is definitely a reduction in water pollution.

B. Relocation of Discharges.

Water quality standards and waste load allocations can be satisfied by relocation of the discharge point of a wastewater effluent. This can be accomplished either by direct transportation of a treated effluent to a less critical reach of a stream or by regionalization of two or more entities by constructing an interceptor sewer to treat wastewater at one main plant.

When considering regionalization, the problem is to determine whether it is more feasible, both in terms of economics and water quality, to operate one or more smaller plants or to transport sewage to a larger plant. In general, the larger the treatment plant, the more economical the operation.

Assuming low flow conditions in a stream and conventional secondary treatment, it is possible that present stream standards may tend to allow less regionalization of wastewater treatment, since they are not compatible with the condition of poor quality water in a short reach of stream along with higher quality water in long reaches. Under these same conditions, relocation of a wastewater discharge to a different point in a stream would not be practical, since this would only transfer a potential water quality problem from one area to another. Furthermore, relocating wastewater discharge points to take advantage of unused stream assimilative capacity would violate the policy of the State of Texas on antidegradation of existing higher stream quality.

In general, the advantages of regionalization lie in efficiency and economy of construction and operation, and the disadvantages lie in the cost of collecting and transporting the wastewater from individual areas to the regional plant. According to the Highland Lakes Report, "Preliminary cost estimates indicated that, except for some of the smaller communities in the Austin area, it would not be economically feasible to collect and transport the wastewater from several cities to an area-wide plant for treatment. Likewise, preliminary cost estimates indicated that it would not be economically feasible, within the design period, to collect the wastewater from many of the Highland Lakes septic tank areas and transport it to an area-wide plant for treatment."

However, it is believed that in areas where existing or proposed treatment facilities appear to be in reasonable proximity to be considered for regionalization that this alternate be applied and its cost be compared to the cost of two or more separate facilities.

The relocation of wastewater discharges without further treatment will not meet the goals of P. L. 92-500.

C. Diversion from Basin.

This alternative would call for exporting wastewater to an adjacent river basin. There are a number of reasons why, when considering this method of water quality enhancement for the Colorado River Basin, it would be highly undesirable. In the first place, the waste load allocations of adjacent river basins have not yet been determined, so that although it could possibly improve water quality in some reaches of the Colorado River, the problem may simply be shifted laterally from this Basin to another. Also, in most cases, the cost of such an alternative would exceed the cost of the best technically-achievably tertiary treatment methods.

One important aspect which must be considered with exporting wastewater from an area is its value as a resource, especially in the upper portion of the Basin where freshwater sources are becoming scarce. This is confirmed by the Texas Water Plan of 1968 or the Plan which proposes, by year 2020, supplying 95,000 acre-feet annually for municipal and industrial use in the Abilene, Colorado City, San Angelo, Snyder, and Sweetwater areas. About 171 thousand acre-feet would be made available to this region for irrigation. Also, approximately 505,000 acre-feet would be available for municipal and industrial use in the Lubbock, Big Spring, Midland, Odessa, Pecos, and El Paso areas.

In summary, this alternate will not be considered desirable for the Colorado River Basin either in terms of water quality enhancement or economics, which not only includes the cost of transporting the wastewater but also the loss of a valuable resource, especially in years to come.

The transferring of pollution problems from one basin to another is not compatible with the intent of PL 92-500.

D. Flow Regulation

Flow regulation, commonly called flow augmentation, consists of releasing water during periods of low natural runoff to dilute or disperse effluent which would be continually entering a stream. The source of the flow augmentation water is generally a reservoir. Sustaining certain minimum stream flows by this method also insures adequate water supplies to downstream users, in addition to improving water quality.

There are two principal ways in which flow augmentation can affect water quality. The first is through dilution accompanying the increased flows. The augmentation water should have a higher DO content, a lower

BOD, lower nutrient levels, and lower concentrations of toxic chemicals than agricultural, domestic, or industrial effluents entering the stream. The greater the amount of such augmentation water, with respect to effluents, the better the water in the stream should be.

The second way flow augmentation can affect water quality is through physical effects accompanying increased flow. These include increases in flow velocity, altered rates of gas exchange, and altered expanses of ripple conditions in the stream.

Flow augmentation is practiced to some extent in the Colorado River Basin below the Highland Lakes by the Lower Colorado River Authority. However, this occurs only approximately six months out of the year during the rice-growing season when a considerable amount of water must be released to sustain this operation. The major exception to the above is when releases are necessary to lower the reservoir levels to maintain flood storage in the reservoirs.

Section 102(b) of the Federal Water Pollution Control Act Amendments of 1972 requires that in the planning of any reservoir by a Federal Agency, inclusion of storage for regulation of streamflow shall be considered, except that such storage shall not be provided as a substitute for adequate treatment or other methods of controlling waste at the source. According to the Environmental Protection Agency's "Policy on Storage and Releases for Water Quality Control in Reservoirs Planned by Federal Agencies" sent to all regional administrators by William D. Ruckelshouse, dated January 16, 1973, "Over the past several years, advancements in pollution control technology, together with an increasing recognition of the limitations of flow augmentation as a means of enhancing water quality, have indicated that reservoir storage for water quality control is generally a poor substitute for at-source pollution control measures."

Therefore, from the above discussion, flow augmentation will not be considered in this report as a potential method of meeting water quality objectives in the Colorado River Basin.

E. In-Stream Modifications.

This alternate would consist of in-stream aeration and mixing by mechanically adding to the supply of oxygen available for waste stabilization. The Ruhrveband in Germany is successfully using in-stream aeration as a component of the water management system for the Ruhr River; studies of the Potomac Estuary indicate that stream aeration would

be several times as economical as advanced waste treatment; and preliminary studies of the Houston Ship Channel, Texas consider this a potential method for upgrading water quality to acceptable levels.

The above examples, however, are instances where the quality of water in the streams was brought to a degraded condition as a result of large volumes of industrial and domestic effluents. Under these conditions, it was found more economically feasible to set aside certain reaches of a stream for wastewater stabilization purposes rather than constructing more advanced wastewater treatment facilities at the points of origin.

With respect to the Colorado River Basin, the reach of the river above the Highland Lakes would not support an in-stream aeration system due to extended periods of zero flow. The Highland Lakes are presently in excellent condition, with respect to quality, and are not threatened by industrial activity. There is concern, however, due to the large number of septic tanks in existence along the shores of the lakes. This potential source of pollution is being studied for the Texas Water Quality Board. In-stream aeration would not be feasible here, due to the vast size of the lakes and the number of aeration units that would be required to transfer any substantial amount of oxygen, but primarily due to the large amount of direct contact recreation, including boating, fishing, swimming, and skiing that would be adversely affected by such facilities--not to mention aesthetics. Also, since the lakes are a source of municipal drinking water, converting any one or all of them into a wastewater treatment facility would be condemned by the public.

Finally, the stretch of the Colorado River below the Highland Lakes, which will be considered as extending from Longhorn Dam in Austin to the tidal waters of the river, is the only area where in-stream aeration could conceivably be considered. From modeling studies by the Texas Water Development Board in this reach of the river, it was indicated that, assuming a 10-year, 7-day low flow condition in the river and permitted water quantity and quality conditions for municipal discharges, a violation of dissolved oxygen requirements as set by the Texas Water Quality Board would occur below the City of Austin and below the City of Wharton. However, according to projected wastewater flows, this volume will not occur until about 1987 and, assuming the 1983 requirements of the Federal Water Pollution Control Act Amendments of 1972 will be complied with, this violation of the dissolved oxygen requirements will probably never come about. Under these conditions, in-stream aeration would not have to be considered.

F. Water Reuse.

Proper management and maximum possible reuse of municipal, industrial, and agricultural wastewater is an integral part of the Texas Water Plan. Return flows will be recognized more as an essential and valuable resource as water requirements increase in the future. These return flows will be available to supply downstream demands, including fresh water inflows for bays and estuaries.

The industrial uses of renovated municipal wastewater have been classified as (a) cooling water makeup, (b) boiler feed water, (c) process makeup, and (d) other uses. The latter includes such uses as oil well flooding, ore processing, wash water, and fire protection. Many industries using renovated municipal wastewater provide additional in-plant treatment consisting of chemical treatment followed by filtration, even for cooling water makeup.

Water costs reported by various municipalities and industries nationwide range from 2¢/1000 gallons to 15¢/1000 gallons for delivered renovated wastewater. The total water costs to industries, including in-plant treatment, vary from 4¢/1000 gallons to $1.00/1000 gallons. The El Paso Products Chemical Company in Odessa, Texas, as an example, utilizes about 6 million gallons per day of municipal wastewater effluent from the City of Odessa at a cost of approximately 15¢/1000 gallons. The water is used for cooling and boiler feed and is given extensive in-plant tertiary treatment at an additional cost to that company of about 57¢/1000 gallons.

The use of sewage effluent for the production of agricultural crops is an accepted practice in many areas of the United States as well as Texas. Sewage plant effluents have been approved in Texas for the irrigation of field crops grown for animal feed. The uses of renovated effluent for land application in Texas include irrigation of animal feed crops such as pasture grasses and grains, irrigation of parks, cemeteries, and golf courses.

The economic contribution of effluent to the State with respect to agriculture is difficult to estimate. The Texas Water Development Board Report No. 9, entitled "Use of Sewage Effluent for Production of Agricultural Crops," estimates that agriculture returns $44 to $51 per acre-foot of water used. The value will vary greatly with different crops and the influence (assuming beneficial) that sewage effluent has on production. The estimated value of an acre-foot of water varies from about $16.50 for an average of several crops to $78.50 for cotton.

In general, the effluent is donated by municipalities to the users if they defray costs involved in removing it from the plant site. In other cases, the user pays a stipulated sum for the use of the effl ent, and some are charged on a quantity basis of so much per 1,000 gallons.

Agricultural reuse of effluent is widely practiced in the upper portion of the Colorado River Basin. Water is applied to a variety of crops generally used for cattle feeding, either on privately-owned farmland or on land owned by a municipality. Land application of effluent has several advantages. First, the municipality is usually able to sell the effluent. Second, the effluent, in addition to being an available water irrigation source to decrease the demand on existing diminishing ground and surface water sources, has been shown to have important fertilizer value in most crops, and thus increase production. Finally, in addition to having an agricultural value, land application of wastewater has been shown to be a very effective means of advanced wastewater treatment. Land application may result in no discharge of the effluent to a receiving stream; thus, preservation of water quality by elimination of wastewater sources may be accomplished by this method.

G. <u>Control of Wastewater Quantities by Zoning and/or Planned Growth</u>.

This alternative applies to municipalities which are generally composed of four types of land use: (1) residential--both single and multifamily, (2) commercial, (3) industrial, and (4) parks and open spaces which may not contribute wastewater. Zoning is a method of accomplishing planned growth. By specifying the type of land use that may occur in various areas of a municipality, a better control over the quantity and quality of wastewater originating from specific areas may be accomplished. This is especially important in areas where there are existing collection systems which were designed to serve specific land-use types proposed in specific areas. One problem which is arising in many of the larger municipalities in the country at present is, as an example, residential areas which are served by collection systems designed for single-family units. When multi-family development occurs in these areas, the population density for a particular tract may increase from 10 people per acre to 20 or 30 people per acre. The sewage contribution also takes a similar rise. Thus, the existing collection system may become inadequate, depending on the extent of such development. In such instances, zoning is a very effective means of controlling wastewater quantities.

Most municipalities have prepared master plans for development and planning growth for the future. The ideal goal is to construct sewage collection systems into an area before an extensive amount of development

occurs. There are several factors which, however, limit planning in this respect. The first is that municipalities can exercise control only so far from city limits to require compliance to city codes. Second, under what is considered good planning, if a city constructs or extends a trunk line or major interceptor sewer into a particular area anticipating substantial development, the price of the land in this area may increase to the point where developers cannot afford to build in the area and are forced to move to another area not served by such facilities. This affect, to some extent, can also be brought about by simply proposing facilities into an area in a master plan for a city.

Although planning may not solve all problems with respect to wastewater quantity, it is essential for municipalities for which future development is projected. The advantages of planned development far outweigh any disadvantages that may occur.

The new law (PL 92-500) has made the control of wastewater quantities by zoning and/or planned growth a part of the Basin plan, in accordance with 40 CFR Part 131 and is, therefore, not considered a Basin plan alternative. This was developed by the Texas Water Quality Board and is shown in Section II of this volume, subsection entitled "Coordination with Land Use Policies and Controls."

H. Combinations of the Above.

In meeting water quality objectives, or any objectives for that matter, there is generally never one specific answer to the many problems. As the problem of meeting these objectives is complex, so is the solution. In evaluating the Basinwide alternatives above, those believed to be feasible, at least with respect to consideration in this study, are as follows:

(1) Treatment
(2) Relocation of Discharge (regionalization)
(3) Water Reuse
(4) Control of Wastewater Quantities by Zoning and/or Planned Growth

It can be seen that these individual alternates may be utilized in conjunction with each other in arriving at the best possible solution to the problem. For example, if treatment is in existence at a municipality by two or more separate treatment plants, regionalization of two or more plants may be more economically advantageous over the study period. At the same time, zoning and planned growth may be beneficial to treatment, regardless of the number of facilities utilized.

Treatment and Water Reuse are already a feasible combination, as evidenced by its being done in the Basin at the present time.

Finally, it may be desirable to incorporate all four alternatives at the same time. As an example, zoning and planned growth may complement treatment which may occur at one or more plants, followed by reuse of the effluent by industrial and/or agricultural purposes. As mentioned before, agricultural use of the effluent may further enhance the treatment process either by producing a high quality effluent or eliminating the discharge altogether.

The enactment of PL 92-500 brought about an entirely new concept across the nation to eliminate all pollution of the nation's waters. Provisions of this act ruled out all alternatives that had been previously considered with the exception of the treatment alternative, which is the only condition that meets the intent of the new act in relation to the control of domestic and industrial point sources of wastes. The combinations of treatment with reuse or regionalization is considered as a treatment alternative, since treatment is the most essential component of the combinations. The control of wastewater quantities by zoning and/or planned growth is now part of the plan preparation, in accordance with 40 CFR Part 131 and is therefore not considered a Basin plan alternative.

Conclusion.

Further detailed consideration of all eight Basin alternatives was not justified, since the only alternative that is in compliance with the intent of PL 92-500 is the "treatment" alternative. However, reuse and regionalization were included with the treatment alternative, where feasible, in order to achieve efficient utilization of wastewater through economies of scale. Table VII-A is presented as a summary of a detailed evaluation of three sewage treatment process types that were considered to be viable treatment alternatives in meeting the intent of PL 92-500.

Recommendation.

A review of the evaluation of treatment alternative (Table VII-A) confirms that the "treatment" alternative meets the intent of PL 92-500. Therefore, it is recommended that the "treatment" alternative, in conjunction with reuse and regionalization, where feasible, be utilized as the implementation strategy throughout the Colorado River Basin, Texas.

TABLE VII - A

EVALUATION OF TREATMENT ALTERNATIVES

Elements	Advanced Biological Systems			Physical/Chemical Systems			Land Disposal Systems
	Secondary	Best Practicable	Best Available	Secondary	Best Practicable	Best Available	No Discharge of Critical Pollutants
A. Environmental Quality							
1. Water Resource							
a. Effluent Quality	Approximately 90% removal of BOD and SS.	Approximately 95% removal of BOD and SS. Some removal of nutrients.	Approximately 98% removal of BOD and SS. High removal of nutrients.	Approximately 90% removal of BOD and SS.	Approximately 95% removal of BOD and SS. Some removal of nutrients.	Approximately 98% removal of BOD and SS. High removal of nutrients.	Of very high quality. Accomplishes no discharge objective. Recoverable waters suitable for M&I use.
b. Groundwater	Nitrates could detrimentally affect ground-water quality.	Suitability for higher uses negates recharge probability.	Suitability for higher uses negates recharge probability.	Nitrates could detrimentally affect ground-water quality	Suitability for higher uses negates recharge probability.	Suitability for higher uses negates recharge probability.	Positive recharge potential. Nitrates removed by plant uptake and/or percolation.
c. Streamflow (assuming discharges)	Degradation of stream quality. Possible eutro-phic conditions.	Slight degrada-tion of stream quality.	Acceptable for discharge. No degradation of stream quality.	Degradation of stream quality.	Slight degrada-tion of stream quality.	Acceptable for discharge. No degradation of stream quality.	Reduction of stream flow possible. Flows from percola-tion or underdrains would not degrade stream quality.
2. Air Resource	Possible odors from primary and secondary processes.	Possible odors from primary and secondary processes.	Possible odors from primary and secondary processes.	Slight odors. Less than biological systems.	Slight odors. Less than biological systems.	Slight odors. Less than biological systems.	Aerosol potential small. Possible slight odors at secondary process.
3. Land Resource	Acreage require-ments small relative to influ-ent volume. Plant siting and zoning characteristics.	Acreage require-ments small relative to influ-ent volume. Plant siting and zoning characteristics.	Acreage require-ments small relative to influ-ent volume. Plant siting and zoning characteristics.	Acreage require-ments small relative to influ-ent volume. Plant siting and zonin characteristics.	Acreage require-ments small relative to influ-ent volume. Plant siting and zoning characteristics.	Acreage require-ments small relative to influ-ent volume. Plant siting and zoning characteristics.	Large acreages required for long periods of time. Potential reclaiming of semi-arid land. Increased productivity.

TABLE VII - A (Cont'd.)

Elements	Advanced Biological Systems			Physical/Chemical Systems			Land Disposal Systems
	Secondary	Best Practicable	Best Available	Secondary	Best Practicable	Best Available	No Discharge of Critical Pollutants
A. Environmental Quality (Cont'd.)							
4. Biological							
a. Zoological	Usually little effect because systems sited near urban areas.	Usually little effect because systems sited near urban areas.	Usually little effect because systems sited near urban areas.	Usually little effect because systems sited near urban areas.	Usually little effect because systems sited near urban areas.	Usually little effect because systems sited near urban areas.	Could alter wildlife habitat characteristics causing movement of certain species (i.e., deer) if irrigation lands not currently available.
b. Botanical	Small effect on area adjacent to plant sites other than site preparation. Nutrients reaching stream could cause . increase in aquatic plants.	Small effect on area adjacent to plant sites other than site preparation. Reduction of nutrients to stream; therefore, less chance for eutrophic conditions.	Small effect on area adjacent to plant sites other than site preparation. High reduction of nutrients; therefore, slight chance for eutrophic conditions.	Small effect on area adjacent to plant sites other than site preparation. Nutrients reaching stream could cause increase in aquatic plants.	Small effect on area adjacent to plant sites other than site preparation. Reduction of nutrients to stream; therefore, less chance for eutrophic conditions.	Small effect on area adjacent to plant sites other than site preparation. High reduction of nutrients; therefore, slight chance for eutrophic conditions.	If not currently irrigating, could require extensive clearing of land. Possible conversion of natural vegetation to crops or pasture lands.
5. Geological	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	Could affect rate of recharge of groundwater.
B. Social							
1. Manpower	Additional personnel may be required. Skilled operators may be available locally.	Additional personnel may be required. Highly skilled technical personnel may not be available locally.	Additional personnel may be required. Highly skilled technical personnel may not be available locally.	Additional personnel may be required. Skilled operators may be available locally	Additional personnel may be required. Highly skilled technical personnel may not be available locally.	Additional personnel may be required. Highly skilled technical personnel may not be available locally.	

TABLE VII - A (Cont'd.)

Elements	Advanced Biological Systems			Physical/Chemical Systems			Land Disposal Systems
	Secondary	Best Practicable	Best Available	Secondary	Best Practicable	Best Available	No Discharge of Critical Pollutants
B. Social (Cont'd.)							
2. Aesthetics	System location usually affects direction of residential growth. System could achieve aesthetic harmony by physical or vegetative screening.	System location usually affects direction of residential growth. System could achieve aesthetic harmony by physical or vegetative screening.	System location usually affects direction of residential growth. System could achieve aesthetic harmony by physical or vegetative screening.	System location usually affects direction of residential growth. System could achieve aesthetic harmony by physical or vegetative screening.	System location usually affects direction of residential growth. System could achieve aesthetic harmony by physical or vegetative screening.	System location usually affects direction of residential growth. System could achieve aesthetic harmony by physical or vegetative screening.	System location could affect direction of urban growth. Could be used as a buffer of green belt.
3. Historical, Archeological and Cultural	Any effects are dependent on recommended site. Specific investigations required prior to site selection. Care should be taken due to numerous known sites in Basin.	Any effects are dependent on recommended site. Specific investigations required prior to site selection. Care should be taken due to numerous known sites in Basin.	Any effects are dependent on recommended site. Specific investigations required prior to site selection. Care should be taken due to numerous known sites in Basin.	Any effects are dependent on recommended site. Specific investigations required prior to site selection. Care should be taken due to numerous known sites in Basin.	Any effects are dependent on recommended site. Specific investigations required prior to site selection. Care should be taken due to numerous known sites in Basin.	Any effects are dependent on recommended site. Specific investigations required prior to site selection. Care should be taken due to numerous known sites in Basin.	Any effects are dependent on recommended site. Specific investigations required prior to site selection. Care should be taken due to numerous known sites in Basin.

TABLE VII - A (Cont'd.)

Elements	Advanced Biological Systems			Physical/Chemical Systems			Land Disposal Systems
	Secondary	Best Practicable	Best Available	Secondary	Best Practicable	Best Available	No Discharge of Critical Pollutants
B. Social (Cont'd.)							
4. Public Health	Acceptable MPN levels on all biological agents with exception of some viruses.	Acceptable MPN levels on all biological agents with exception of some viruses.	Acceptable MPN levels on all biological agents with exception of some viruses.	Acceptable MPN levels on all biological agents plus some deactivation of viruses.	Acceptable MPN levels on all biological agents plus some deactivation of viruses.	Acceptable MPN levels on all biological agents plus some deactivation of viruses.	Acceptable MPN levels on all biological agents plus total deactivation of viruses.
5. Political Acceptability	System presently utilized in most areas. No change from current State policy.	Degree of technical sophistication may require more intergovernmental coordination.	Degree of technical sophistication may require more intergovernmental coordination.	System not utilized in most areas, but acceptable in meeting current water quality objective.	System not utilized in most areas, but acceptable in meeting current water quality objective.	System not utilized in most areas, but acceptable in meeting current water quality objective.	System presently utilized in many areas. Acceptable to most Basin entities, especially in upper (semi-arid) Basin.
C. Economic Development	Additional employment required. Initiate proper management of resource.	Increase in skilled employment. Increase in value of streambank property.	Increase in skilled employment. Potential for industrial and/or municipal reuse; therefore, larger revenue potential. Increase water contact recreational opportunity. Increase in value of streambank property.	Additional employment required. Initiate proper management of resource.	Increase in skilled employment. Increase in value of streambank property.	Increase in skilled employment. Potential for industrial and/or municipal reuse; therefore, larger revenue potential. Increase water contact recreational opportunity. Increase in value of streambank property.	Increase in agricultural revenue per acre. Additional employment required.

TABLE VII - A (Cont'd.)

Elements	Advanced Biological Systems			Physical/Chemical Systems			Land Disposal Systems
	Secondary	Best Practicable	Best Available	Secondary	Best Practicable	Best Available	No Discharge of Critical Pollutants
D. Technology							
1. Reliability and Flexibility	Generally reliable. Subject to occasional mechanical failure. Susceptible to shock or toxic loadings.	Generally reliable. Subject to occasional mechanical failure. Susceptible to shock or toxic loadings.	Generally reliable. Subject to occasional mechanical failure. Susceptible to shock or toxic loadings.	More reliable. Subject to occasional mechanical failure. Less susceptible to shock or toxic loadings. Adjustments in treatment processes readily accomplished.	More reliable. Subject to occasional mechanical failure. Less susceptible to shock or toxic loadings. Adjustments in treatment processes readily accomplished.	More reliable. Subject to occasional mechanical failure. Less susceptible to shock or toxic loadings. Adjustments in treatment processes readily accomplished.	Requires constant hydraulic infiltration. Finite renovation capacity of soil (life span). May require holding facilities during wet or cold weather.
2. Construction Effects	Temporary disruption. May change access to open spaces, resources and service. Disruption of traffic patterns and existing activities. Noise and dust from construction activities.	Temporary disruption. May change access to open spaces, resources and service. Disruption of traffic patterns and existing activities. Noise and dust from construction activities.	Temporary disruption. May change access to open spaces, resources and service. Disruption of traffic patterns and existing activities. Noise and dust from construction activities.	Temporary disruption. May change access to open spaces, resources and service. Disruption of traffic patterns and existing activities. Noise and dust from construction activities.	Temporary disruption. May change access to open spaces, resources and service. Disruption of traffic patterns and existing activities. Noise and dust from construction activities.	Temporary disruption. May change access to open spaces, resources and service. Disruption of traffic patterns and existing activities. Noise and dust from construction activities.	Possible disruption of rural setting, destruction of botanical elements and alteration of wildlife habitat.
E. Institutional Arrangements	No problems under recommended Institutional Arrangements.	No problems under recommended Institutional Arrangements.	No problems under recommended Institutional Arrangements.	No problems under recommended Institutional Arrangements.	No problems under recommended Institutional Arrangements.	No problems under recommended Institutional Arrangements.	No problems under recommended Institutional Arrangements.

TABLE VII - A (Cont'd.)

Elements	Advanced Biological Systems			Physical/Chemical Systems			Land Disposal Systems
	Secondary	Best Practicable	Best Available	Secondary	Best Practicable	Best Available	No Discharge of Critical Pollutants
*F. Resource Conservation	Small commitment of nonrenewable resources. Energy requirements for pumping, blowers, etc. are function of influent volume.	Small commitment of nonrenewable resources. Energy requirements for pumping, blowers, etc. are function of influent volume.	Small commitment of nonrenewable resources. Energy requirements for pumping, blowers, etc. are function of influent volume.	Chemical requirements would commit large quantities of nonrenewable resources. Total energy requirements higher than for biological systems.	Chemical requirements would commit large quantities of nonrenewable resources. Total energy requirements higher than for biological systems.	Chemical requirements would commit large quantities of nonrenewable resources. Total energy requirements higher than for biological systems.	Large land areas committed for long periods of time. Very high energy requirements for pumping, transmission, etc. Possible destruction of vegetation if irrigation not presently used.

Cost Comparisons for Implementing the Recommended Alternative.

Non-Metropolitan Areas.

In essence, all proposals presented in the area-wide plans accompanying and providing a basis for this report can be classified as either a discharge or no-discharge alternative. Characteristic of the semi-arid Colorado River Basin of Texas is the need for utilization of treated wastewater flows to supplement the agricultural economy. It is for that reason that a majority of the proposals contained in the area-wide plans look to wastewater reuse through agriculture as the most cost-effective method of providing a high degree of treatment. So as not to preclude a local option to the proposed method of treatment, a logical alternative treatment method was conceived and associated costs generated.

The single defined objective of all non-metropolitan area planning was to develop proposals which were consistent with the rationale utilized to interpret the PL 92-500. A full definition of that rationale is contained in the Technical Appendix to this study. In the development of the basic and alternative proposals, the following were considered:

a. Present and Projected Water Resources and Needs
b. Technical Feasibility
c. Political Acceptability
d. Cost Effectiveness
e. Applicability
f. Constraints
g. Potential for Public Use
h. Environmental Compatibility
i. Compatibility with Local Level Planning

To summarize the vast amount of work and planning contained in the volumes accompanying this Basin Plan, the following table was devised to show a relative cost comparison between the no-discharge and discharge alternatives. As stated previously, both alternatives are capable of meeting the objectives of the law, and initiation of an element associated with meeting the 1977 objective as listed under one alternative does not preclude the implementing entity from selecting an element associated with meeting the 1983 objective from the other alternative. For example, if the discharge alternative were composed of a modification to an existing secondary facility by 1977, followed by partial tertiary treatment by 1983, and the no-discharge alternative were composed of construction of a new replacement secondary facility

by 1977, followed by land disposal, an entity could meet the water quality objective by a combination of upgrading the present facility by 1977, followed by land disposal. The listing therefore does not intend to preclude choice of alternatives.

Each non-metropolitan city or area for which planning has been accomplished is presented in the following table, together with as much coded information as could practically be summarized in a legible format. Codes were developed to indicate the planning region in which the area lies, the stream segment into which the area would discharge, the status of any existing treatment facilities, and, finally, a generalized statement as to the construction of the specific proposed element together with its associated total project cost. Therefore, the coding for Andrews, Texas "OO, PB, 6e, k (1977)," should be interpreted as:

"The City does not lie within the area directly tributary to a designated stream segment, the City is within the Permian Basin Regional Planning Commission, and the treatment facilities are of the activated sludge type employing total retention and effluent irrigation as the method of effluent disposal. Continuance of total irrigation is recommended for the no-discharge alternative. No costs are associated with this alternative."

Interpretations of the various codes are presented following the comparative costs to meet water quality objectives table.

Metropolitan Areas.

As a special directive to the participants in this study, it was desired to develop a minimum of ten alternative treatment schemes to meet stated water quality objectives for each of six metropolitan areas. These metropolitan areas were defined as Austin, Big Spring, Brownwood, Midland, Odessa, and San Angelo, Texas. The water quality objectives were two-fold: first, a single plan was required to meet a waste load allocation. Pursuant to passage of PL 92-500, initial mathematical modeling investigations and waste load allocation calculations, this plan evolved into a plan to meet the objectives and milestones of the law. Second, nine alternatives were to be developed to meet the highest level of treatment goals utilizing biological, physical-chemical, and/or land disposal techniques. Third, regionalized treatment was to be considered in certain specific instances.

Presentation and discussion of all alternatives is included in the area-wide plans which accompany this report. An inclusion herein of a cost comparison, inclusive of all alternatives, was considered to be impractical. For extremely practical reasons, the choice of alternatives for three of the areas should be a logical continuation of the present method of disposal.

TABLE VII - 1

COUNTY	CITY	STREAM SEGMENT	PLANNING AREA	FACILITY STATUS	COMPARATIVE COSTS TO MEET WATER QUALITY OBJECTIVES					
					NO DISCHARGE ALTERNATIVE			DISCHARGE ALTERNATIVE		
					1977	1983	NDP	1977	1983	NDP
ANDREWS	Andrews	12	PB	6e; b	K				I - $307,000	J - $270,000
BASTROP	Bastrop	02	CA	6a	A - $358,500	G - $239,700		A - $358,500	I - $190,000	J - $168,000
	Elgin	02	CA	4a	G - $244,600			A - $281,700	I - $156,000	J - $143,000
	Smithville	02	CA	4a	A - $358,500	G - $253,000		A - $358,500	I - $190,000	J - $168,000
BLANCO	Johnson City	14	CA	2c	B - $ 42,300 D			A - $139,500	I - $102,000	J - $ 99,000
BROWN	Bangs	10	WC	7a	A - $157,000	G - $ 97,000		A - $157,000	I - $119,000	J - $ 84,000
	Lake Brownwood	18	WC	6b	H - $ 5,000				I - $139,000	J - $123,000
BURNET	Burnet	04	CA	6b	K				I - $186,000	J - $162,000
	Marble Falls	05	CA	4a	A - $207,900	G - $195,000		P - $ 44,500	R - $223,500	
CALLAHAN	Clyde	20	WC	1a	G - $ 89,000			B - $ 23,000	I - $106,000	J - $103,500
	Cross Plains	20	WC	2c	A - $141,000 G - $ 98,000				I - $102,000	J - $ 74,000
COCHRAN	Whiteface	13	SP	2e	G - $ 24,220			A - $ 57,900	M - $ 72,400	N - $ 58,000
COKE	Bronte	10	CV	2b	K			A - $103,700	I - $ 91,800	J - $ 85,500
	Robert Lee	10	CV	6a	F				I - $129,500	J - $107,500
COLEMAN	Coleman	18	WC	2c		G - $ 74,000		A - $358,500	I - $196,000	J - $167,000
	Santa Anna	10	WC	2a	G - $ 91,000			A - $123,000	I - $ 92,800	J - $ 85,500
COLORADO	Columbus	02	HG	6a		G - $215,000			I - $162,000	J - $143,000
	Eagle Lake	02	HG	4a	G - $228,200			A - $358,500	I - $156,000	J - $143,000
	Garwood	02	HG	4a	G - $ 44,000			A - $ 76,000	I - $ 78,800	J - $ 78,500
	Weimar	02	HG	7a	G - $116,300				I - $122,000	J - $ 84,000
CONCHO	Eden	16	CV	2a	F			A - $193,120	I - $122,000	J - $ 84,000
DAWSON	Lamesa	12	PB	4b	K			A - $627,500	I - $343,000	J - $244,000
ECTOR	Goldsmith	12	PB	0	A - $103,700	G - $ 17,600		A - $103,700	M - $ 72,400	N - $ 58,000

TABLE VII - 1 (Cont'd.)

COUNTY	CITY	STREAM SEGMENT	PLANNING AREA	FACILITY STATUS	COMPARATIVE COSTS TO MEET WATER QUALITY OBJECTIVES					
					NO DISCHARGE ALTERNATIVE			DISCHARGE ALTERNATIVE		
					1977	1983	NDP	1977	1983	NDP
EDWARDS	Rockspring	15	MRG	0	A - $157,600	G - $ 78,600		A - $157,600	I - $121,000	J - $ 80,000
FAYETTE	Carmine	02	CA	0	A - $ 76,000	G - $ 45,440			I - $ 72,300	J - $ 71,000
	Ellinger	02	CA	6a					M - $ 64,400	N - $ 53,000
	Fayetteville	02	CA	6a		G - $ 31,600			M - $ 72,400	N - $ 58,000
	La Grange	02	CA	3a	A - $358,500	G - $225,800		A - $358,500	I - $145,000	J - $135,000
GAINES	Seagraves	12	PB	6b; e	B - $275,900 D			A - $252,210	I - $122,000	J - $ 84,000
	Seminole	12	PB	2b	K			A - $358,500	I - $182,000	J - $141,000
GILLESPIE	Fredericksburg	14	AA	6a	C - $358,500	H - $282,000			I - $205,000	J - $174,000
GLASSCOCK	Garden City	25	PB	0	A - $ 74,700	F		A - $ 74,700	I - $ 67,200	J - $ 56,000
HAYS	Buda	02	CA	2b; e	F			A - $ 95,200	I - $ 87,500	J - $ 81,000
	Dripping Springs	02	CA	0	A - $ 95,200	G - $ 57,000		A - $ 95,200	I - $ 87,500	J - $ 81,000
HOCKLEY	Sundown	13	SP	2b	B - $ 12,930 K			A - $121,700	I - $ 88,000	J - $ 87,500
HOWARD	Coahoma	12	PB	1b	B - $ 10,700 K			A - $102,600 $ 87,600 $133,650	I - $ 96,000	J - $ 92,500
	Sand Springs	12	PB	0	L $326,970, K			A - $130,540	I - $ 87,500	J - $ 81,000
IRION	Mertzon	24	CV	0	A - $ 76,000	F		A - $ 76,000	I - $ 77,000	J - $ 61,000
KIMBLE	Junction	15	CV	2b	K			A - $193,100	I - $128,500	J - $ 88,800
LAMPASAS	Lometa	09	CT	0	A - $ 73,000	G - $ 56,100		A - $ 76,000	I - $ 77,000	J - $ 61,000
LEE	Giddings	02	CA	2a	D			A - $175,200	I - $121,000	J - $ 84,000
	Giddings State Boys School	02	CA	6a	F				I - $ 97,000	J - $ 77,000

TABLE VII - 1 (Cont'd.)

COUNTY	CITY	STREAM SEGMENT	PLANNING AREA	FACILITY STATUS	COMPARATIVE COSTS TO MEET WATER QUALITY OBJECTIVES					
					NO DISCHARGE ALTERNATIVE			DISCHARGE ALTERNATIVE		
					1977	1983	NDP	1977	1983	NDP
LLANO	Kingsland Lake	06	CA	0	A - $158,000	G - $130,000		Q - $191,000	L	
	Kingsland	06	CA	0	A - $358,500	G - $410,000		Q - $429,120	R - $299,000	
	Llano	15	CA	2c	D	E - $ 66,240		A - $157,360	I - $164,000	J - $131,000
	Sunrise Beach	06	CA	0	A - $431,900	G - $ 55,000		Q - $336,000	Q - $286,000 R - $330,000	
	Tow	08	CA	0	A - $ 91,700	G - $ 63,000		Q - $110,840	R - $137,800	
MARTIN	Stanton	12	PB	2b	B - $ 34,100 K			A - $193,100	I - $129,000	J - $117,500
MASON	Mason	15	CV	2c	D			A - $157,400	I - $106,000	J - $103,500
McCULLOCH	Brady	16	CV	4c	D			A - $346,700	I - $178,500	J - $167,000
MENARD	Menard	16	CV	3c	F			A - $139,500	I - $105,000	J - $ 99,000
MILLS	Goldthwaite	10	CT	3b	A - $193,100 K			A - $193,100	I - $114,000	J - $103,500
MITCHELL	Colorado City	12	WC	4b	K			A - $334,900	I - $172,000	J - $137,000
	Loraine	12	WC	3c	G - $ 61,000			A - $193,100	I - $ 76,800	J - $ 61,000
REAGAN	Big Lake	24	CV	2c	K			A - $193,000	I - $122,000	J - $ 84,000
RUNNELS	Ballinger	10	WC	3a	B - $198,000 G - $182,000			A - $360,000	I - $145,500	J - $130,000
	Miles	21	WC	2b	G - $ 8,100			A - $ 74,000	I - $ 72,300	J - $ 71,000
	Winters	10	WC	2b	A - $223,000, K			A - $223,000	I - $139,000	J - $119,000
SAN SABA	Richland Springs	16	CT	3b	D - $ 22,500			A - $ 68,700	M - $ 72,400	N - $ 58,000
	San Saba	16	CT	3b	K			A - $121,600	I - $102,000	J - $ 99,000
SCHLEICHER	Eldorado	24	CV	2b	K			A - $ 95,200	I - $ 87,500	J - $ 81,000
SCURRY	Snyder	12	WC	4c	G - $330,000			A - $729,600	I - $273,000	J - $220,000
STERLING	Sterling City	25	CV	0	A - $ 95,500	F		A - $ 95,500	I - $ 87,000	J - $ 81,000

TABLE VII - 1 (Cont'd.)

COUNTY	CITY	STREAM SEGMENT	PLANNING AREA	FACILITY STATUS	COMPARATIVE COSTS TO MEET WATER QUALITY OBJECTIVES					
					NO DISCHARGE ALTERNATIVE			DISCHARGE ALTERNATIVE		
					1977	1983	NDP	1977	1983	NDP
TERRY	Brownfield	13	SP	2b	A - $627,500 K			A - $627,500	I - $343,000	J - $244,000
	Meadow	13	SP	1b	B - $ 5,100 D			A - $157,300	I - $ 72,300	J - $ 71,000
TOM GREEN	Sanatorium—Carlsbad	25	CV	3b	K, L			A - $222,700	I - $139,000	J - $119,000
TRAVIS	Dell Valle	02	CA	0	L			A - $ 68,710	I - $ 72,300	J - $ 71,000
	Jonestown	04	CA	0	A - $157,500	G - $130,000		Q - $191,000	R - $180,000	
	Lago Vista	04	CA	0	G,A - $846,000			A - $616,200	I - $343,000	J - $244,000
	Manor	02	CA	2a	G - $ 29,140	L		A - $121,600	I - $ 97,300	J - $ 77,000
	Oak Hill	02	CA	0	L			A - $ 95,200	I - $ 87,500	J - $ 81,000
	Pflugerville	02	CA	0	A - $109,620	G - $ 32,990		A - $109,620	I - $ 92,800	J - $ 85,500
	Point Venture	04	CA	6b	K A - $157,560			A - $157,560	I - $314,000	J - $269,000
	Rollingwood	02	CA	0	L			A - $121,600	I - $ 96,000	J - $ 92,500
	Sunset Valley	02	CA	0	L			A - $ 68,710	I - $ 72,300	J - $ 71,000
	Westlake Hills	02	CA	0	L			A - $193,100	I - $128,000	J - $ 88,000
	Pedernales Country Club	04	CA	6b	K					
WHARTON	Wharton	02	HG	4a	B - $252,000 G - $551,200			A - $627,500	I - $343,000	J - $244,000
YOAKUM	Denver City	12	SP	1b 2b	B - $54,200, K B - $61,500, K			A - $351,000	I - $172,000	J - $137,000
	Plains	12	SP	2a	B - $ 17,600 D			A - $110,000	I - $122,000	J - $ 99,500

TABLE VII - 1 (Cont'd.)

ADJACENT LAKE	AREA	STREAM SEGMENT	PLANNING AREA	FACILITY STATUS	COMPARATIVE COSTS TO MEET WATER QUALITY OBJECTIVES					
					NO DISCHARGE ALTERNATIVE			DISCHARGE ALTERNATIVE		
					1977	1983	NDP	1977	1983	NDP
TRAVIS	Marshall Ford	04	CA	0	A - $ 79,600	G - $ 50,000		Q - $ 97,600	R - $126,500	
	Windy Point	04	CA	0	A - $157,500	G - $130,000		Q - $190,700	R - $180,000	
	Volente	04	CA	0	A - $228,200	G - $240,000		Q - $276,000	R - $224,000	
	Hudson Bend	04	CA	0	A - $133,800	G - $105,000		Q - $162,500	R - $169,800	
	Trails End Road	04	CA	0	A - $ 73,600	G - $ 44,000		Q - $ 90,500	R - $121,000	
	Buffalo Gap	04	CA	0	A - $ 55,400	G - $ 27,500		Q - $ 72,300	R - $104,400	
	Hurst Creek Arm	04	CA	0	L			Q - $103,700	R - $131,800	
	Bee Creek – East	04	CA	0	A - $ 79,600	G - $ 50,000		Q - $ 97,680	R - $126,500	
	Bee Creek – West	04	CA	0	A - $ 79,600	G - $ 50,000		Q - $ 97,680	R - $126,500	
	Therman Bend	04	CA	0	A - $ 55,400	G - $ 27,500		Q - $ 72,300	R - $104,400	
	Lakeway	04	CA	6b,6b	K A - $639,900			A - $639,900	I - $170,000	J - $144,000
	Cox Hollow	04	CA	0	A - $ 67,500	G - $ 36,000		Q - $ 83,200	R - $115,300	
	Whitecliff Corp.	04	CA	6	–	–	–	–	–	–
	Old Ferry Road	04	CA	0	A - $ 73,600	G - $ 44,000		Q - $ 90,500	R - $121,000	
	Gloster Bend	04	CA	0	A - $ 91,700	G - $ 63,000		Q - $112,000	R - $137,800	
	Spicewood Beach Area	04	CA	0	A - $ 85,700	G - $ 54,000		Q - $104,920	R - $131,800	
MARBLE FALLS	Cottonwood Shores	05	CA	0	A - $157,500	G - $130,000		Q - $178,600	R - $180,000	
LYNDON B. JOHNSON	Horseshoe Bay	06	CA	6b	K				I - $220,000	J - $181,000
	Sandy Creek	06	CA	0	A - $121,600	G - $ 88,000		Q - $147,000	R - $158,800	
	Walnut Creek	06	CA	0	A - $ 85,700	G - $ 55,000		Q - $104,920	R - $131,800	
	Dry Creek	06	CA	0	A - $121,600	G - $ 90,000		Q - $147,000	R - $158,800	
	Sherwood Shores – Granite Shoals	06	CA	0	A - $394,000	G - $450,000		Q - $469,300	R - $320,000	
	Backbone Mt. – South	06	CA	0	A - $121,600	G - $ 90,000		Q - $147,000	R - $158,800	
	Backbone Mt. – North	06	CA	0	A - $ 91,700	G - $ 63,000		Q - $112,000	R - $137,800	
	Williams Creek	06	CA	0	A - $ 91,700	G - $ 63,000		Q - $112,000	R - $137,800	
	Haywood	06	CA	0	A - $ 55,400	G - $ 27,500		Q - $ 69,900	R - $104,400	

TABLE VII - 1 (Cont'd.)

ADJACENT LAKE	AREA	STREAM SEGMENT	PLANNING AREA	FACILITY STATUS	COMPARATIVE COSTS TO MEET WATER QUALITY OBJECTIVES					
					NO DISCHARGE ALTERNATIVE			DISCHARGE ALTERNATIVE		
					1977	1983	NDP	1977	1983	NDP
LYNDON B. JOHNSON (Cont'd)	Hoovers Valley	06	CA	0	A - $ 44,500	G - $ 18,000		Q - $ 57,810	R - $ 91,400	
	Murchison	06	CA	0	A - $ 49,400	G - $ 23,000		Q - $ 63,960	R - $ 96,800	
INKS	Inks Lake State Park	07	CA	0	–	–	–	–	–	–
	North Inks Lake	07	CA	0	A - $ 85,700	G - $ 54,000		Q - $105,000	R - $131,800	
BUCHANAN	Buchanan Dam	08	CA	0	A - $121,600	G - $ 90,000		Q - $147,000	R - $158,800	
	Wirth Haven Cove	08	CA	0	A - $103,700	G - $ 73,000		Q - $126,460	R - $142,800	
	Jeckers Cove	08	CA	0	A - $ 67,500	G - $ 37,000		Q - $ 83,200	R - $115,300	
	Negrohead	08	CA	0	A - $103,700	G - $ 73,000		Q - $125,250	R - $142,800	
	Rocky Point	08	CA	0	A - $ 44,500	G - $ 18,000		Q - $ 56,530	R - $ 91,400	
	Lion Mountain	08	CA	0	A - $ 46,930	G - $ 19,500		Q - $ 60,270	R - $ 93,600	
	Spider Mountain	08	CA	0	A - $139,800	G - $110,000		Q - $168,980	R - $178,500	
	White Bluff	08	CA	0	A - $204,900	G - $190,000		Q - $247,400	R - $213,000	
	Alexander Branch	08	CA	0	A - $ 61,500	G - $ 33,000		Q - $ 77,200	R - $110,000	
	Maxwells Slough	08	CA	0	A - $67,500	G - $ 37,000		Q - $ 83,200	R - $115,300	

The City of Odessa presently sells all effluent to a local refinery and is producing a revenue from reuse of a scarce natural resource. The cities of Midland and San Angelo currently dispose of all effluent through irrigation of cropland. In these instances, there is no foreseeable reason why the cities should alter their disposal method, since in each case the method is wholly in compliance with the no-discharge of pollutants and highest level of treatment requirements of the Amendments. For presentation purposes, the evaluation analysis matrix for each metropolitan area plan was scanned and a reasonable alternative was selected for comparison in the following table.

For the remaining metropolitan areas of Austin, Big Spring, and Brownwood, two most cost-effective plans were selected for inclusion in the Table. As stated previously, these two alternatives do not preclude the other alternatives detailed in the area-wide plans but are, in the best judgment of the Engineers, those plans which should be given more detailed consideration.

The letter codes preceding the expenditure requirements and describing the stream segment, the planning area, and the status of existing facilities are the same as those utilized in the previous non-metropolitan section.

TABLE VII - 2

METROPOLITAN AREA	STREAM SEGMENT	PLANNING AREA	FACILITY STATUS	ALTERNATIVE PLAN	IMPLEMENTATION COSTS 1977	IMPLEMENTATION COSTS 1983	IMPLEMENTATION COSTS NDP
AUSTIN	02	CA		a. **Discharge:**			
			6a	*Walnut Creek Plant:* Construct new 18.0 mgd secondary facility by 1975. Expand secondary plant to 28.0 mgd by 1983 and add biological tertiary treatment.	A-\$5,587,200[1]	C-\$3,489,000 I-\$3,244,800	N-\$2,733,100
			6a	*Govalle Plant:* Existing secondary capacity adequate through period. Add biological tertiary treatment.		I-\$3,107,400	N-\$2,623,000
			1e	*Williamson Creek Plant:* Expansion of existing aeration ponds by 1975. Abandon plant by 1980 and construct new secondary facility at proposed Onion Creek site. Add biological tertiary treatment.	C-\$121,600	A-\$3,034,200 I-\$1,247,800	N-\$2,678,200
				b. **No Discharge:**			
				All Plants: Expand and construct secondary facilities as described above. Construct transmission, storage, and irrigation facilities, and purchase land for land disposal site (2,840 acres @ \$1,000/ac.)	A-\$5,587,200[1] C-\$121,600	C-\$3,489,000 A-\$3,034,200 G-\$17,147,000	

[1] *Costs presented represent secondary treatment facilities only as detailed in area-wide plan.*

TABLE VII - 2 (Cont'd.)

METROPOLITAN AREA	STREAM SEGMENT	PLANNING AREA	FACILITY STATUS	ALTERNATIVE PLAN	IMPLEMENTATION COSTS		
					1977	1983	NDP
BIG SPRING	12	PB		*Hays Plant:*			
			5d	a. **No Discharge:** Continue industrial reuse.	–	–	–
				b. **Discharge:** Abandon plant, route flow to adjacent main plant, include flow in main plant expansion.	C-$124,000		
			4a	*Trickling Filter Plant:*			
				a. **No Discharge:** Expand secondary facilities to 3.5 mgd by 1977. Initiate land disposal tertiary treatment by 1983 (incl. 420 ac. land @ $250/ac.).	C-$1,118,000	G-$1,555,000	
				b. **Discharge:** Expand secondary facilities to 3.5 mgd by 1977. Add biological tertiary treatment.	C-$1,118,000	I-$740,000	J-$680,000

TABLE VII - 2 (Cont'd.)

METROPOLITAN AREA	STREAM SEGMENT	PLANNING AREA	FACILITY STATUS	ALTERNATIVE PLAN	IMPLEMENTATION COSTS 1977	1983	NDP
BROWNWOOD	17	WC	4a	a. **No Discharge:** Renovate existing trickling plant and initiate land disposal tertiary treatment by 1977.	B-\$300,000 G-\$1,199,000		
				b. **Discharge:** Modify existing trickling filter plant to activated sludge by 1977. Add biological tertiary treatment.	B-\$860,000	I -\$681,000	J-\$583,000
MIDLAND	12	PB	6b	a. **No Discharge:** Continue total irrigation.	–	D.	–
				b. **Discharge:** Initiate biological tertiary treatment.	–	I -\$1,164,200	J-\$3,029,800
ODESSA	12	PB	6d	a. **No Discharge:** Expand existing secondary facilities by 1977, and continue industrial reuse.	C-\$1,116,000		
				b. **Discharge:** Expand existing secondary facilities by 1977, and initiate biological tertiary treatment.	C-\$1,116,000	I -\$1,536,600	J-\$4,873,400

TABLE VII - 2 (Cont'd.)

METROPOLITAN AREA	STREAM SEGMENT	PLANNING AREA	FACILITY STATUS	ALTERNATIVE PLAN	IMPLEMENTATION COSTS		
					1977	1983	NDP
SAN ANGELO	21	CV	7b	a. **No Discharge:** Construct conventional secondary facilities by 1977 and continue total irrigation.	A-$2,150,000		
				b. **Discharge:** Construct convential secondary facilities by 1977 and initiate biological tertiary treatment.	A-$2,150,000	M-$1,299,600	

STREAM SEGMENT CODE

1401	Colorado River tidal
1402	Colorado River - above tidal to Tom Miller Dam, including Town Lake
1403	Lake Austin
1404	Lake Travis
1405	Lake Marble Falls
1406	Lake Lyndon B. Johnson
1407	Inks Lake
1408	Lake Buchanan
1409	Colorado River - Lake Buchanan headwater to San Saba River Confluence
1410	Colorado River - San Saba River confluence to E. V. Spence Reservoir (Robert Lee Dam)
1411	E. V. Spence Reservoir
1412	Colorado River - FM 2059 near Silver to Lake J. B. Thomas (Colorado River Dam)
1413	Lake J. B. Thomas
1414	Pedernales River
1415	Llano River
1416	San Saba River
1417	Pecan Bayou - Colorado River confluence to Lake Brownwood Dam
1418	Lake Brownwood
1419	Lake Coleman

1420 Pecan Bayou - above Lake Brownwood

1421 Concho River - Colorado River confluence to fork in San Angelo, including South Fork to Lake Nasworthy Dam and North Fork to San Angelo Reservoir Dam

1422 Lake Nasworthy

1423 Twin Buttes Reservoir

1424 South and Middle Concho Rivers - above Twin Buttes Reservoir

1425 San Angelo Reservoir

PLANNING AREA CODE

AA - Alamo Area
CA - Capital Area Planning Council
CV - Concho Valley
CT - Central Texas
HG - Houston-Galveston Area Council
MR - Middle-Rio Grande Development Council
PB - Permian Basin Regional Planning Commission
SP - South Plains Association of Governments
WC - West Central Texas Council of Governments

FACILITY STATUS CODE

0 - No existing facilities
1 - Stabilization ponds
2 - Imhoff tank-stabilization ponds
3 - Imhoff tank-trickling filter
4 - Trickling filter
5 - Hays Process
6 - Activated Sludge Processes
7 - Miscellaneous

a - Effluent Discharge
b - Effluent Irrigation
c - Seasonal Effluent Discharge or Irrigation
d - Industrial Reuse
e - Total Retention

TREATMENT ALTERNATIVE CODE

A. Construct conventional secondary facilities.
B. Modify existing irrigation operation.
C. Expand existing secondary facilities.
D. Initiate year-round irrigation practice.
E. Expand existing irrigation operation.
F. Provide effluent to adjacent irrigated areas.
G. Construct and operate irrigation disposal facilities.

H. Modify existing irrigation operation.

I. Partial filtration, phosphorus, ammonia-nitrogen and organic nitrogen reduction.

J. Total filtration, denitrification, and further phosphorus reduction.

K. Continue total irrigation.

L. Regionalized treatment.

M. Total filtration, phosphorus, ammonia-nitrogen and organic nitrogen reduction.

N. Denitrification and further phosphorus reduction.

P. Filtration.

Q. Construction of conventional secondary facilities with total filtration.

R. Nitrification, denitrification and phosphorus reduction.

VIII. PROPOSED WATER QUALITY MANAGEMENT STRATEGY

Role of Water Quality Standards in Strategy.

The Colorado River Basin, Texas lies in a semi-arid area and, as such, a majority of all tributary streams statistically could be termed intermittent. Dependent upon the historical return period to be utilized in analysis and waste load allocation, the number of streams which would have sufficient flow to allow an allocation would be minimal.

For the purposes of this Study, a decision was reached by the Governor's Planning Committee that the analysis flow condition agreeable to all parties was the 10-year, 7-day low flow condition. Return-flow analysis subsequently performed by the Texas Water Development Board utilizing historical stream records indicated that the only reaches of the river or its tributaries which had significant flow for the condition were those areas of the main stem below Austin where the river was sustained by reservoir release and municipal return flow from the City of Austin.

Mathematical modeling of the river for the purpose of waste load allocation was therefore restricted realistically to those reaches between the tidal influence and the City of Austin. In the context of making an allocation subject to no violation of existing stream standards, the Texas Water Development Board--the modeling agency--was directed by the Corps of Engineers to load the model with ever-increasing return flows from dischargers within the reaches. The return flows were projected by the Texas Water Quality Board, utilizing population projections developed by the Development Board. Results of the modeling effort indicated that no violation of stream standards was likely to occur as a result of discharges from properly-operated secondary treatment facilities until about 1988.

During the course of this Study, PL 92-500 was enacted and, as such, became integral to the planning process. As stated in the Technical Appendix-Treatment Level Rationale, a definition of phases and levels of treatment cited in the law was made to allow the Study to continue on schedule. Definitions of "secondary treatment," "best practicable waste treatment technology," and "no discharge of pollutants," as interpreted for this Study are included in the Rationale.

In essence, although no apparent violation of standards would occur until 1988, the requirements of the law that all publicly-owned or municipal discharges attain the best practicable waste treatment technology by 1983 was the limiting design condition. All planning for these reaches contained in the accompanying area-wide reports was therefore directed toward the goals of the law.

Throughout the remainder of the Basin where streamflow was intermittent under the 10-year, 7-day criteria, the receiving waters were initially classified by the Texas Water Quality Board as effluent-limiting segments. As such, the milestone goals of the law became the planning objectives for treatment facilities tributary to the segment, and resultant area-wide plans were prepared.

In the final weeks of the Study, several effluent-limiting segments were reclassified as water quality limiting segments. As such, a waste load allocation, as described elsewhere in this volume, was made for each constituent which had caused a violation of stream standards. The allocation was based on a 2-year, 7-day return flow in accordance with recently enacted State allocation methodology. Calculations based upon this return period indicated that all area-wide planning accomplished to date, utilizing the law interpretation, was not affected by the reclassification of segments. The implementation requirements of the law were therefore more severe than would be required by a waste load allocation, and the actual role of stream standards in the proposed strategy was minimal. Should waste loads increase unexpectedly or other unforseen demands on the water resource develop, this Study should be reviewed in the Continuing Planning Process to be certain no violation of stream standards occurs as a result of the prescribed levels of treatment.

Elements of Abatement Strategy.

Municipal Construction Needs.

In the previous section of this report were detailed two basic alternatives available to each private or publicly-owned municipal waste treatment facility to meet water quality objectives. In the refinement of an overall strategy to meet the water quality objectives of the Basin Plan, the apparent most cost-effective plan for each facility was selected and carried forward into the development of construction needs and Basinwide system of fiscal resource allocation priorities.

In an effort to eliminate two separate listings of both needs and priorities, the construction needs were included in the Basin priority listing which follows. The alphameric construction codes are those utilized in the previous alternative section. The codes are repeated herein for convenience.

The milestones utilized to develop the construction needs and priority listings are those of PL 92-500. Three construction needs lists were therefore developed: one to meet each of the law objectives of 1977, "secondary treatment"; 1983, "best practicable waste treatment technology"; and "no discharge of pollutants." The rationale and methodology defining and accomplishing these objectives is contained in the Technical Appendix, Volume 3 of this report. Three listings were necessary, since a given facility's priority was subject to change for each period. The listings by definition become construction compliance schedules if the goals of the law are to be met.

Discharge permit conditions for levels of constituents are defined to be those levels prescribed in the rationale and methodology sections previously referenced. For convenience, the following summary presents the permit levels anticipated for the Basin.

ANTICIPATED PERMIT CONSTITUENT LEVELS

Area	Constituent	CONCENTRATION (mg/l) 1977	1983	NDP
General Basin	BOD_5	20	12	8
	TSS	20	9	4
	P	2	2	0.2
	N	30	30	2
	DO	5	5	5
Highland Lakes	BOD_5	8	8	8
	TSS	4	4	4
	P	2	2	0.2*
	N	30	30	2*
	DO	5	5	5

*Implementation schedule dependent on current studies detailed in Area-wide plan rationale.

NOTE: For process efficiencies and assumptions, refer to Volume 3, Technical Appendixes.

Municipal Priority List.

In order to develop a Basinwide listing of construction priorities, a ranking was devised that utilized three key elements and associated weights. A discussion of the methodology used in developing the priority list is included in Appendix H of the Basin Plan Appendixes.

The ranking of the Facility Construction Elements was based on the philosophy of lending priority to the alleviation of water quality problems associated with prior constructed facilities. By construction of a collection and treatment system, a point source of pollution is created, and responsibility then exists to ensure that the facility continues to produce an acceptable quality effluent. For this reason, in the allocation of a fiscal resource, modifications, expansions, and replacement of existing secondary facilities should have more weight than improving the level of general treatment throughout the Basin.

To compensate for relative location within the Basin, the stream segments into which the proposed facilities would discharge have been given weights comparable with the segment's relative ranking within the Basin. The rankings were compiled by the TWQB under the methodology described in the Basin Plan Appendixes.

Finally, a weight was given to the facility according to the facility's method of effluent disposal. In the national effort to eliminate the discharge of pollutants, significance is noted and has been placed on the effort of municipalities to seek agricultural or industrial reuse of wastewater.

Actual priority ranking was made from a totalization of all weights associated with a construction project. The weight totals which were not numerically sequential were arranged to develop the listings which follow. In instances where the weight totals for two or more projects were numerically the same, the influent BOD loadings to the facility were utilized to rank the projects. In this ranking, priority was given to the facility with the greatest influent load.

The respective priority lists are presented in Tables VIII-1, 2, and 3. This priority list was developed for the purpose of this report, which included developing proposed compliance scedules and construction starts. The Statewide Project Funding Priority List prepared twice per year by the TWQB is the controlling document for Federal funding priorities.

PRIORITY RANKING
WEIGHT ASSIGNMENTS

Facility Construction Element

Weight	Element
45	Upgrade Existing Secondary Facilities
40	Expand Existing Secondary Facilities
35	Replace Existing Secondary Facilities
30	Construct New Secondary Facilities
25	Install Stormwater Clarification Facilities
20	Install Partial Tertiary Facilities
15	Install Complete Tertiary Facilities
10	Control of Urban Runoff
5	Control of Non-Urban Runoff

Discharge Location - Stream Segment Elements

Weight	Segment	Stream Ranking Basin	State
25	1417	1	15
24	1413	2	46
23	1402	3	56
22	1401	4	63
21	1412	5	71
20	1420	6	78
19	1410	7	87

Weight	Segment	Stream Ranking Basin	State
18	1404	8	115
17	1403	9	137
16	1408	10	138
15	1407	11	139
14	1406	12	140
13	1419	13	144
12	1418	14	145
11	1425	15	146
10	1423	16	147
9	1416	17	213
8	1415	18	226
7	1405	19	240
6	1414	20	249
5	1411	21	265
4	1409	22	266
3	1422	23	272
2	1424	24	273
1	1421	25	274

Discharge - No Discharge Element

Weight	
20	Facility Has/Will Have No Discharge
10	Facility Has/Will Have a Discharge

CONSTRUCTION NEED CODE

A. Construct conventional secondary facilities.

B. Modify existing secondary facilities.

C. Expand existing secondary facilities.

D. Initiate year-round irrigation practice.

E. Expand existing irrigation operation.

F. Provide effluent to adjacent irrigated area.

G. Construct and operate irrigation disposal facilities.

H. Modify existing irrigation operation.

I. Partial filtration, phosphorus, ammonia-nitrogen and organic nitrogen reduction.

J. Total filtration, denitrification, and further phosphorus reduction.

K. Continue total irrigation.

L. Regionalized treatment.

M. Total filtration, phosphorus, ammonia-nitrogen and organic nitrogen reduction.

N. Denitrification and further phosphorus reduction.

P. Filtration.

Q. Construct conventional secondary facilities with total filtration.

R. Nitrification, denitrification and phosphorus reduction.

TABLE VIII - 1

BASINWIDE PRIORITY LISTING AND CONSTRUCTION NEEDS INVENTORY

1977 Objective

City of Area	Basin Priority	Construction Need Code	Construction Need Cost	Type of Facility
San Angelo	1	A,K	$2,150,000	New 7.36 MGD secondary activated sludge unit to replace existing plant.
Goldthwaite	2	A,K	193,100	New 0.2 MGD secondary biological plant to replace existing plant.
Mertzon	3	A	76,000	New 0.05 MGD secondary biological plant.
LaGrange	4	A	358,500	Abandon the existing facility and construct a 0.50 MGD secondary activated sludge plant.
Brownwood	5	B,G	1,499,000	$300,000 renovation of existing system and a 520 acre irrigation system costing $1,199,000
Wharton	6	B,G	803,400	Addition of a parallel 0.3 MGD activated sludge secondary unit and the construction of an 189 acre irrigation facility to treat the effluent from the combined plants.
Ballinger	7	B,G	380,000	Renovation of the existing facility and the addition of a clarifier, chlorinator, preaerator and a 69 acre irrigation facility.
Austin Williamson Creek	8	C	121,600	Expansion of the 3.0 MGD secondary facility to a 4.5 MGD secondary facility.
Johnson City	9	B	42,300	Clean and repair Imhoff tank, drain and excavate oxidation ponds and fence the area.
Cross Plains	10	A,G	239,000	New 0.125 MGD secondary biological plant to replace the existing plant.
Big Spring Trickling Filter	11	C	1,118,000	Modification and expansion of existing 2.8 MGD trickling filter secondary treatment facility to a 3.5 MGD activated sludge secondary treatment facility.
Winters	12	A,K	223,000	New 0.25 MGD secondary activated sludge unit to replace existing plant.

TABLE VIII - 1 (Cont'd.)

City of Area	Basin Priority	Construction Need: Code	Construction Need: Cost	Type of Facility
Austin				
Walnut Creek	13	A	$5,587,200	New 18.0 MGD secondary activated sludge plant.
Lakeway Area	14	A,K	639,900	New 1.1 MGD secondary biological regional plant to serve the Lakeway area and possibly the Hurst Creek area.
Point Venture	15	A,K	157,560	New .150 MGD secondary biological plant and abandon the .036 MGD plant in existence.
Lago Vista	16	A,G	846,000	New 1.0 MGD secondary biological plant and an irrigation system to further treat the effluent.
Denver City				
North Plant	17	B,K	54,200	Construct new primary settling pond and additional 2.8 acres oxidation ponds.
South Plant	18	B	61,500	Additional sludge drying beds and additional 4.5 acres oxidation ponds.
Seagraves	19	B,D	275,900	Replace existing 0.35 MGD Imhoff tank with new 0.35 MGD primary clarifier and digestion facilities.
Stanton	20	B,K	34,100	Replace existing 0.20 MGD Imhoff tank with a new 0.26 MGD preliminary treatment and digestion facilities additional 2.0 acres of oxidation ponds.
Coahoma	21	B,K	10,700	Additional 0.5 acre oxidation pond.
Plains	22	B,D	17,600	Additional 1.0 acre oxidation pond.
Sundown	23	B,K	12,930	Construct new preliminary treatment facilities for existing 0.14 MGD secondary facility.
Meadow	24	B,D	5,100	Construct new preliminary treatment facilities for existing 0.05 MGD secondary facilities.
Bastrop	25	A	358,500	New 0.50 MGD secondary activated sludge facility utilizing some of the existing components.
Pflugerville	26	A	109,620	New 0.09 MGD secondary biological plant and a 12.5 acre irrigation system.
Dripping Springs	27	A	95,200	New 0.07 MGD secondary biological plant.
Smithville	28	A	358,500	Abandon existing plant and construct a 0.50 MGD secondary activated sludge plant.

TABLE VIII - 1 (Cont'd.)

City of Area	Basin Priority	Construction Need		Type of Facility
		Code	Cost	
Carmine	29	A	$ 76,000	New 0.05 MGD extended aeration secondary plant.
Odessa	30	C	1,116,000	Expansion of existing 6.0 MGD activated sludge facility to a 10.0 MGD activated sludge secondary treatment facility.
Bangs	31	A	157,000	New 0.19 MGD secondary biological plant to replace existing Imhoff tank.
Eagle Lake	32	G	228,200	Construction of an irrigation facility on 92 acres of land since the existing plant's effluent will not be suitable for 1977 requirements.
Elgin	33	G	244,600	Construction of an irrigation facility on 82 acres of land since the existing plant's effluent will not be suitable for 1977 requirements.
Weimar	34	G	116,300	Construction of an irrigation facility on 41 acres of land since the existing plant's effluent will not be suitable for 1977 requirements.
Volente Area	35	Q	276,000	New 0.26 MGD secondary biological plant and new 0.26 MGD filtration plant.
Jonestown	36	Q	191,000	New 0.15 MGD secondary biological plant and new 0.15 MGD filtration plant.
Hudson Bend	37	Q	162,500	New 0.12 MGD secondary biological plant and new 0.12 MGD filtration plant.
Manor	38	G	29,140	Construct irrigation facility on leased land in lieu of new STP.
Windy Point Area	39	Q	190,700	Construct new 0.15 MGD secondary biological plant and new 0.15 MGD filtration plant.
Trails End Road Area	40	Q	90,400	Construct new 0.05 MGD secondary biological plant and new 0.05 MGD filtration plant.
Bee Creek–West Area	41	Q	97,680	Construct new 0.055 MGD secondary biological plant and new 0.055 MGD filtration plant.
Bee Creek–East Area	42	Q	97,680	Construct new 0.055 MGD secondary biological plant and new 0.055 MGD filtration plant.

TABLE VIII - 1 (Cont'd.)

City of Area	Basin Priority	Construction Need		Type of Facility
		Code	Cost	
Old Ferry Road Area	43	Q	$ 90,500	Construct new 0.05 MGD secondary biological plant and new 0.05 MGD filtration plant.
Garwood	44	G	44,000	Construction of an irrigation facility on eight acres of land since the existing plant's effluent will not be suitable for 1977 requirements.
Gloster Bend Area	45	Q	112,000	Construct new 0.07 MGD secondary biological plant and new 0.07 MGD filtration plant.
Spicewood Beach Area	46	Q	104,920	Construct new 0.06 MGD secondary biological plant and new 0.06 MGD filtration plant.
Buffalo Gap Area	47	Q	72,300	Construct new 0.03 MGD secondary biological plant and new 0.03 MGD filtration plant.
Therman Bend Area	48	Q	72,300	Construct new 0.03 MGD secondary biological plant and new 0.03 MGD filtration plant.
Marshall Ford Area	49	Q	97,600	Construct new 0.055 MGD secondary biological plant and new 0.055 MGD filtration plant.
Cox Hollow Area	50	Q	83,200	Construct new 0.04 MGD secondary biological plant and new 0.04 MGD filtration plant.
Fredericksburg	51	C	358,500	Expand existing facilities by construction of a 1.0 MGD parallel contact stabilization unit.
Snyder	52	G	330,000	Construct a 158 acre irrigation facility.
White Bluff Area	53	Q	247,400	Construct new 0.22 MGD secondary biological plant and new 0.22 MGD filtration plant.
Buchanan Dam Area	54	Q	147,000	Construct new 0.10 MGD secondary biological plant and new 0.10 MGD filtration plant.
Loraine	55	G	61,000	Construct a 15 acre irrigation facility.
Spider Mountain Area	56	Q	168,980	Construct new 0.125 MGD secondary biological plant and new 0.125 MGD filtration plant.

TABLE VIII - 1 (Cont'd.)

City of Area	Basin Priority	Construction Need Code	Construction Need Cost	Type of Facility
Tow	57	Q	$ 110,840	Construct new 0.07 MGD secondary biological plant and new 0.07 MGD filtration plant.
Wirth Haven Cove	58	Q	126,460	Construct new 0.08 MGD secondary biological plant and new 0.08 MGD filtration plant.
Negrohead Area	59	Q	125,250	Construct new 0.08 MGD secondary biological plant and new 0.08 MGD filtration plant.
Alexander Branch Area	60	Q	77,200	Construct new 0.036 MGD secondary biological plant and new 0.036 MGD filtration plant.
Maxwells Slough Area	61	Q	83,200	Construct new 0.04 MGD secondary biological plant and new 0.04 MGD filtration plant.
Jeckers Cove Area	62	Q	83,200	Construct new 0.04 MGD secondary biological plant and new 0.04 MGD filtration plant.
Rocky Point Area	63	Q	56,530	Construct new 0.02 MGD secondary biological plant and new 0.02 MGD filtration plant.
Lion Mountain Area	64	Q	60,270	Construct new 0.023 MGD secondary biological plant and new 0.023 MGD filtration plant.
Clyde	65	G	89,000	Construct a 30 acre irrigation facility.
North Inks Lake Area	66	Q	105,000	Construct new 0.06 MGD secondary biological plant and new 0.06 MGD filtration plant.
Sherwood Shores Granite Shoals	67	Q	469,300	Construct new 0.55 MGD secondary biological plant and new 0.55 MGD filtration plant.
Kingsland	68a	Q	429,120	Construct new 0.50 MGD secondary biological plant and new 0.50 MGD filtration plant.
Kingsland Lake Area	68b	Q	191,000	Construct new 0.15 MGD secondary biological plant and new 0.15 MGD filtration plant.
Sunrise Beach	69	Q	336,000	New 0.35 MGD contact stabilization plant, advanced treatment facility, standby power generator and lift station.
Santa Anna	70	G	91,000	Construct a 29 acre irrigation facility.

TABLE VIII - 1 (Cont'd.)

City of Area	Basin Priority	Construction Need Code	Construction Need Cost	Type of Facility
Backbone Mountain South Area	71	Q	$ 147,000	Construct new 0.10 MGD secondary biological plant and new 0.10 MGD filtration plant.
Sandy Creek Area	72	Q	147,000	Construct new 0.10 MGD secondary biological plant and new 0.10 MGD filtration plant.
Dry Creek	73	Q	147,000	Construct new 0.10 MGD secondary biological plant and new 0.10 MGD filtration plant.
Backbone Mountain North Area	74	Q	112,000	Construct new 0.07 MGD secondary biological plant and new 0.07 MGD filtration plant.
Walnut Creek	75	Q	104,920	Construct new 0.06 MGD secondary biological plant and new 0.06 MGD filtration plant.
Williams Creek	76	Q	112,000	Construct new 0.07 MGD secondary biological plant and new 0.07 MGD filtration plant.
Murchison	77	Q	63,960	Construct new 0.025 MGD secondary biological plant and new 0.025 MGD filtration plant.
Haywood	78	Q	69,900	Construct new 0.03 MGD secondary biological plant and new 0.03 MGD filtration plant.
Hoovers Valley	79	Q	57,810	Construct new 0.02 MGD secondary biological plant and new 0.02 MGD filtration plant.
Sterling City	80	A	95,500	Construct a new 0.106 MGD secondary biological plant.
Brownfield	81	A,K	627,500	Construct new 1.0 MGD activated sludge secondary plant.
Sand Springs	82	L,K	326,970	Regionalization with the Coahoma STP, consisting of force main system to Coahoma, and addition of a 0.12 MGD biological secondary treatment plant at Coahoma.
Rockspring	83	A	157,600	Construct a new 0.15 MGD secondary biological plant.
Lake Brownwood State Park	84	H	5,000	Increase the 0.3 acre spray irrigation field to 2.0 acres.
Marble Falls	85	A	44,500	Addition of a 0.23 MGD filtration plant.

TABLE VIII - 1 (Cont'd.)

City of Area	Basin Priority	Construction Need		Type of Facility
		Code	Cost	
Cottonwood Shores	86	Q	$ 178,600	Construct new 0.15 MGD secondary biological plant and new 0.15 MGD filtration plant.
Lometa	87	A	76,000	Construct a new 0.05 MGD secondary biological plant.
Richland Springs	88	D	22,500	Construct a storage lagoon for irrigation system.
Goldsmith	89	A	103,700	Construct a new 0.08 MGD biological secondary plant.
Garden City	90	A	74,700	Construct a new 0.03 MGD biological secondary plant and 1.0 acre holding pond.
Miles	91	G	8,100	Modification and a 1.3 acre expansion of the existing ponds and the addition of a 3.0 acre irrigation facility.
Whiteface	92	G	24,220	Construct new chlorination facilities for existing 0.075 MGD secondary treatment plant and new plastic lining for existing 3.0 acre oxidation pond.

TABLE VIII-2

BASIN-WIDE PRIORITY LISTING
AND
CONSTRUCTION NEEDS INVENTORY

1983 Objective

City or Area	Basin Priority	Total Element Weight	Construction Need	
Austin Walnut Creek	1	73	C, I	$6,733,800
Austin Williamson Creek	2	68	A, I	4,282,000
Smithville	3	58	G	253,000
Bastrop	4	58	G	239,700
La Grange	5	58	G	225,800
Columbus	6	58	G	215,000
Pflugerville	7	58	G	32,990
Carmine	8	58	G	45,440
Dripping Springs	9	58	G	57,000
Fayetteville	10	58	G	31,600
Big Springs Trickling Filter Plant	11	54	G	1,555,000
Bangs	12	54	G	97,000
Austin-Govalle	13	53	I	3,107,400
Kingsland	14	49	R	299,000
Coleman	15	47	G	74,000
Llano	16	43	E	66,240
Volente Area	17	43	R	224,000
Rockspring	18	43	G	78,600
Jonestown	19	43	R	180,000
Hudson Bend	20	43	R	169,800
Windy Point Area	21	43	R	180,000
Trails End Road Area	22	43	R	121,000
Bee Creek - West Area	23	43	R	126,500
Bee Creek - East Area	24	43	R	126,500
Ole Ferry Road Area	25	43	R	121,000
Gloster Bend Area	26	43	R	137,800
Spicewood Beach Area	27	43	R	131,800
Buffalo Gap Area	28	43	R	104,400
Therman Bend Area	29	43	R	104,400
Marshall Ford Area	30	43	R	126,500
Cox Hollow Area	31	43	R	115,300
Marble Falls	32	42	R	223,500

City or Area	Basin Priority	Total Element Weight	Construction Need	
Fredericksburg	33	41	H	$ 282,000
White Bluff Area	34	41	R	213,000
Buchanan Dam Area	35	41	R	158,800
Spider Mountain Area	36	41	R	178,500
Tow	37	41	R	137,800
Wirth Haven Cove	38	41	R	142,800
Negrohead Area	39	41	R	142,800
Alexander Branch Area	40	41	R	110,000
Maxwells Slough Area	41	41	R	115,300
Jeckers Cove Area	42	41	R	115,300
Rocky Point Area	43	41	R	91,400
Lion Mountain Area	44	41	R	93,600
North Inks Lake Area	45	40	R	131,800
Sherwood Shores Granite Shoals	46	39	R	320,000
Sunrise Beach	47	39	Q, R	616,000
Backbone Mountain South Area	48	39	R	158,800
Lometa	49	39	G	56,100
Sandy Creek Area	50	39	R	158,800
Dry Creek Area	51	39	R	158,800
Backbone Mountain North Area	52	39	R	137,800
Walnut Creek Area	53	39	R	131,800
Williams Creek Area	54	39	R	137,800
Murchison Area	55	39	R	96,800
Haywood Area	56	39	R	104,400
Hoovers Valley Area	57	39	R	91,400
Goldsmith	58	35	G	17,600
Cottonwood Shores Area	59	32	R	180,000

TABLE VIII-3

BASIN-WIDE PRIORITY LISTING AND CONSTRUCTION NEEDS INVENTORY NO DISCHARGE OF POLLUTANTS OBJECTIVE

City or Area	Basin Priority	Total Element Weight	Construction Need	
Austin				
Govalle	1	53	N	$2,623,000
Walnut Creek	2	53	N	2,733,100
Williamson Creek	3	53	N	2,678,200

Industrial Waste Loadings

As discussed in Section V, industrial wastewater sources within the Basin are subject to control by the TWQB under the State waste control order permit program. Industrial operations within the Basin consist of livestock operations, sand and gravel washing operations, thermoelectric generation, and heavy industries. In Section VI, Segmentation and Waste Load Allocation, those industrial waste discharges which may be responsible for noncompliance of a given stream segment have been identified and a course of action recommended.

Industrial waste loadings are not expected to increase appreciably within the planning period. In fact, they could easily decrease in several instances. One of the primary reasons for the projected stabilization in amount of industrial discharge is the industrial effluent limitation guidelines as outlined in PL 92-500. (See Section VI.) At this time, these levels have not been defined for those industries in the Basin. However, it is not reasonable to assume that these definitions will permit the discharge of any additional pollutants to the streams within the Basin.

Some general observations are appropriate, however, with reference to future permitting of the industrial operations. Currently, all of the livestock operations are operating under "no-discharge" permit conditions. These facilities dispose of their effluent either by irrigation or by total retention and evaporation. This appears to be the most effective and economical method of disposing of the wastewater and semi-solid wastes generated at these sites. Consequently, it is recommended that the policy of issuing "no-discharge" permits to livestock operations be continued until such time that an economical, technical alternative is developed which would result in a discharge of acceptable quality. Permits issued to date to sand and gravel operations have been extremely variable in the required constituents to be monitored and the concentration levels required. This variable situation is being rectified, in part, by the TWQB order as found in Appendix J of the Basin Plan Appendixes, Vol. 2. It is recommended the Board review all permits and specify uniform flows and constituent levels where appropriate.

Other industrial discharges, including heavy industrial operations and thermoelectric power generation, will require assessment by the Board on a case-by-case basis. Consequently, it is recommended that the TWQB initiate actions with all discharging industries to bring them into full compliance with the requirements of the law as interpreted by the Environmental Protection Agency.

Non-Point Pollution Sources.

As detailed throughout this report, natural or non-point contamination of the fresh waters of the Colorado River Basin is probably the most significant source of stream pollutants. Non-point pollutant sources in the Basin can be classified generally as urban runoff, agricultural runoff, oil-field discharges, and natural deposits of mineral salts. Of these, agricultural return flows and runoff have the least apparent impact on water quality. The only significant return flows known are those associated with rice production in the lower reaches. For these areas, it is recommended the TWQB intensify its efforts in monitoring organic herbicide and pesticide levels in the return flows and in the River. Other agricultural runoff throughout a 39,900-square-mile river basin can be realistically controlled only by the application of sound farming practices. The distribution and magnitude of contamination associated with natural phenomena may place a limitation on the efforts of man toward total elimination of stream contamination. Without the technical or financial resources to eliminate agricultural runoff, it will likely fall that levels of contamination associated with stormwater will remain the background or natural pollution level of the water resource.

Generally, the urban concentrations in the Basin, except for the six defined metropolitan areas, have a population of less than 5,000. The areal extent of these concentrations, as depicted in the land-use discussion included in this report, is but a minute fraction of the total land area of the Basin. Due to the relative size and lack of financial resources to provide other basic services, it is not likely that control of urban runoff from the small cities in the Basin will ever be feasible. The associated runoff will have to remain part of the background pollution level of the water resource.

Two of the metropolitan areas, Austin and San Angelo, offer some possibility for control of urban runoff. Both cities have dense central business districts and, in the case of Austin, developed drainage systems. Collection of urban runoff in the Colorado Basin, where limited topographical relief is available, would be keyed to existing collection systems. In virtually all other metropolitan areas the level terrain allows a multitude of avenues of escape for overland flow. With no defined collection avenues, collection and treatment of urban runoff is not practical. San Angelo has a few small stormwater collection systems, generally in the central business district, which may lend to control. Further investigation on the local level may better define the feasibility of stormwater control and treatment for the city.

The City of Austin is the one metropolitan area within the Basin for which urban runoff concern is warranted, and perhaps feasible. As detailed elsewhere in this report, numerous stormwater systems, in addition to a vast number of direct overland flow discharges, outfall into Town Lake. The lake, which is a part of the municipal water system, may be significantly affected by these discharges. Concern is warranted and further study should be initiated to define the nature of contamination, to determine the safe assimilative capacity of the lake, and to determine the feasibility of a collection and treatment system.

Runoff, discharges, and seepage from areas of oil field activity, in conjunction with river contamination from natural mineral salt deposits, has evolved into the single most eminent water quality concern of residents in the upper Basin. Substantial study beyond the scope of this Wastewater Management Study is necessary to begin to define the problem of salt contamination and locate the logical source, whether it be manmade or natural. The general sources of salt contamination are documented in other reports. During the compilation of this study, the natural background level of salt concentrations was taken, by necessity, as the baseline water quality condition. It is recommended the problem be given specific attention in a comprehensive study, with adequate funding to actually identify sources and provide recommendations and cost estimates for alternative alleviation schemes.

<u>Relation of Strategy to Other Plans.</u>

In the formulation of this report, an attempt was made to collect and review all area-wide planning throughout the Basin which had been accomplished to date. The central responsibility in the collection effort fell to the Governor's Office, Division of Planning Coordination. The documents, plans and technical papers compiled for use in this study are detailed in the Technical Appendixes, Volume 3 of this report.

In the classic planning process, a Basin Plan is first accomplished followed by respective area-wide planning directed toward the goals established by the Basin Plan. Since a vast amount of local and regional area-wide planning had been accomplished prior to initiation of this effort, the scope of the Colorado River Wastewater Management Study was broadened to include development of comprehensive area-wide plans concurrent with the Basin Plan.

Toward development of the area-wide planning documents accompanying this report, Volumes 5, 6, and 7, the planning included in each prior report pertaining to a given area or municipality was assessed for its validity and incorporated where possible in the area-wide plan formulation. Where no area-wide planning was known to be in existence, the Corps of Engineers formulated initial plans based on available soil and topographic data utilizing the best judgment possible. At all times during the area-wide plan formulation, the area planning was cognizant of and responsive to the objectives the Basin Plan was purusing.

In light of a reduction in the availability of the overall national fiscal resource, a pragmatic and realistic attitude toward rural sewerage systems proposed in many prior documents was adopted. Therefore, many of the extensive county-wide collection and treatment systems previously described in comprehensive planning documents were examined in detail, but only incorporated into this Wastewater Management Study if the system had some possibility of self-support.

It was not the intent of this study to supersede all prior area-wide planning documents; rather, the prior documents were to form a base for the comprehensive planning accomplished in conjunction with the Basin Plan. Every attempt was made by the Governor's Office, Division of Planning Coordination, the Texas Water Quality Board, and the Corps of Engineers to locate and incorporate all existing studies. If published planning reports have been inadvertently omitted from consideration, it is hoped the respective municipality or agency will bring these documents to the attention of the TWQB for their consideration in the continuing planning process.

The area-wide plans for the Colorado River Basin are not intended to be the end of area planning in the Basin but rather the beginning of detailed design-oriented planning which can be utilized to better define the costs associated with the proposed plans. Subsequent design cost estimates can then be utilized to evaluate the financial ability of a municipality or area to construct and support the proposed improvements.

STATEWIDE RANKING OF DISCHARGERS [1]

COLORADO RIVER BASIN

MUNICIPAL

Rank Number	Segment	WCO Number	WCO Name
.004573812067974	1412*	1022301	Midland City of
.004391756607220	1420*	1015001	Coleman City of
.004159620613791	1402*	1054303	Austin City of
.003829969005892	1412*	1023801	Odessa City of
.002519459550967	1402*	1054304	Austin City of
.003317997063277	1402*	1002501	Columbus City of
.002329051494598	1402*	1119101	Development Associates Inc.
.001937936991453	1402*	1015201	Colorado County WCID No. 2
.001914627107908	1402*	1010001	Elgin City of
.001614947526832	1402*	1100301	Manor City of
.001446424590540	1417*	1056501	Brownwood City of
.001394158272888	1412*	1006901	Big Spring City of
.001258022370166	1402*	1054311	Austin City of
.001254293398233	1402*	1107601	Bastrop City of
.001177005455247	1402*	1045602	Giddings City of
.000937509867072	1401*	1091301	Matagorda Waste Disposal Corp
.000892648487934	1410*	1032501	Ballinger City of
.000880692001374	1402*	1031101	Weimar City of
.000866289439728	1410*	1012201	Bangs City of
.000823680289614	1402*	1001901	La Grange City of
.000690296234097	1412*	1007701	Colorado City of
.000661843456328	1410*	1027401	Santa Anna City of
.000653285067528	1412*	1043001	Loraine City of
.000517934189702	1412*	1005601	Snyder City of
.000481758219394	1420*	1014901	Clyde City of
.000420628366555	1402*	1084001	Fayetteville City of
.000447826689197	1402*	1094501	Ellinger Sewer & Water Supply
.000408488976973	1410*	1032001	Winters City of
.000401609802793	1402*	1104001	Country Air Inc.

(1) List of Discharger Permit Priorities, provided by the Texas Water Quality Board.

MUNICIPAL (CONT'D)

Rank Number	Segment	WCO Number	WCO Name
.000320324681525	1412*	1022302	Midland City of
.000162191319760	1404*	1053101	Lakeway Mun Utility Dist. #1
.000161694946655	1402*	1102101	Scenic Brook West Inc.
.000040273590002	1402*	1045603	Giddings City of
.000006922339026	1416	1034501	Menard City of
.000000741764765	1415	1020903	Llano City of
.000000569744223	1416	1013201	Brady City of
.000000100023673	1405	1065402	Marble Falls WCID No. 1
.000000023343792	1414	1017101	Fredericksburg City of

STATEWIDE RANKING OF DISCHARGERS

COLORADO RIVER BASIN

INDUSTRIAL

.000362739690900	1401*	45501	Celanese Chemical Company

SEGMENT PLANS

Introduction.

During the period that the Colorado River Wastewater Management Study Draft Report was in printing, the U.S. Environmental Protection Agency on Wednesday, May 23, 1973, released, "Notice of Proposed Rulemaking, Water Quality Management Plans, Preparation Guidelines for States, 40 CFR Part 131."

It is the purpose of this section of the final report to; (a) incorporate all additional items of data, where applicable, that would be required to place the content of the Study in full compliance with the desires and needs of the EPA; (b) place all information or references to details into a segmented format wherein the data would be presented according to each stream segment rather than according to topic as in the body of the report; and (c) to incorporate as applicable the recently proposed National Pollutant Discharge Elimination Systems (NPDES) permit conditions submitted by the Texas Water Quality Board.

Included within each segment plan is a description of the segment, its classification, its ranking within the Basin and State, all known point and non-point sources of pollution, total maximum daily loads where applicable, a segment strategy consisting of proposed permit levels and implementation schedule and, finally, the surveillance and monitoring program for the segment. Each segment plan contains recommendations for stream segment classification and Proposed Water Quality Standards.

Rationale Used for Proposed Effluent Limitations and Compliance Schedule for NPDES.

The purpose of the tables at the end of each segment plan is to assist the State in the planning of NPDES permits, compliance schedules, and funding in accordance with the goals of the Water Quality Management Plan guidelines of EPA, 40 CFR, part 131.

The recommended NPDES flow was determined by the capacity of any new plant (sized for the projected population) proposed by 1977, capacity of an existing plant, capacity of the existing plant after enlargement, or existing permitted flow.

During the conduct of this study a priority list for the Colorado River Basin was not available from the State. Thus, a priority-ranking methodology was developed as a part of this study, utilizing three key elements and their associated weights. These three key elements are: facility construction type, discharge location, and method of effluent disposal. A discussion of this methodology is included as Appendix H of the Basin Plan Appendixes, Volume 2. Permit schedules and construction starts were then developed as functions of the priority.

The permit schedule was determined by:

a. If the priority of the plant was 1-5, as shown on Table VIII-1, then a permit schedule was set at 10/73.

b. If the plant took two or more years to construct, then a permit schedule was set at 10/73.

c. The permit schedule was set at 1/74 for all others, in order to allow sufficient time to design, finance, and construct by 6/77.

Construction start was determined by:

a. If the priority was 1-5, then the start construction date would be two years after the permit, or 10/75.

b. If the priority was 6-23, then the start construction date would be 1/76 unless the construction period was more than 1 1/2 years, then it would be sooner.

c. If the priority was 23-92, then the start construction date would be 6/76, unless the construction period was more than one year.

Exceptions to these guidelines were made when special situations, existing plans, or lengthy construction times warranted them. These exceptions are included in the segment plans.

Effluent limitations of Biological Oxygen Demand (BOD), Suspended Solids (SS), Dissolved Oxygen (DO), and CL_2 Residual were determined from State and Federal standards, type of segment, and proximity of drinking water intakes.

All three goals of PL 92-500, "Secondary," "Best Practicable," and "No Discharge of Pollutants" were considered. In all cases, the recommended treatment facility meets or is more stringent than the requirements of these goals. In those cases that have more stringent requirements, either of three factors controlled:

a. State requirements are more stringent for secondary treatment (20 mg/l BOD_5, 20 mg/l SS) and for the Highland Lakes (5 mg/l BOD_5, 5 mg/l SS).

b. The recommended treatment facility is the most cost effective means of meeting the intent of PL 92-500 for each individual community.

c. The recommended treatment facility is located within a water quality segment (1401, 1412, 1417, 1420) and the implementation of the goals were required at an earlier date.

At least two alternatives were evaluated for each non-metro area, and at least nine alternatives were evaluated for the six metro areas. The estimated capital cost is the first expenditures prior to 1977 for the most cost effective system that can be implemented to meet the intent of PL 92-500.

The alternatives were evaluated on the basis of:

a. Capital cost to include land costs, engineering costs, and contingency costs; and annual operation and maintenance costs, calculated in terms of present worth using interest rates of 5.5, 7, and 10 percent.

b. Feasibility. The initial array of nine or more alternatives for each metro area, utilizing systems which discharged to receiving waters or utilized land treatment or industrial reuse, were systematically screened to the three or four most cost-effective alternatives which would meet Federal, State and local criteria. A similar screening process was utilized for the two or more alternatives for each non-metro area.

c. Environmental effects were evaluated, and possible adverse effects of any alternative were presented to the city officials during the workshops. These environmental effects included, but were not limited to, effluent quality, effects on water resources, construction effects and commitment of land resources.

d. Social and political acceptability. All recommended plans that were chosen by city officials were the most socially and politically acceptable alternative of those presented, as determined by the city officials.

Generally, load reductions are only those required to attain and maintain water quality standards and effluent limitations established by EPA and the State. In some cases the load reduction is greater than needed to satisfy the law, but cost-effective analysis has shown that it is more cost effective to go to higher levels of treatment in 1977 than to wait until 1983. In no case are load reductions recommended which exceed 1977 State and Federal minimum requirements unless the most cost effective treatment method was "no discharge of pollutants"; i.e., land disposal or industrial reuse.

Only those towns with an existing collection system and treatment plant are listed. Construction of new plants to replace septic tanks will be determined by the appropriate State regulatory agencies, on the basis of public health, growth, and available funds.

The costs do not include collection costs, since they are independent of the type of treatment plant and are not part of a cost-effective analysis of existing plants.

The capital costs were determined by the use of curves, based on 1972 prices, developed for the U.S. Environmental Protection Agency by various consultants, by use of existing literature and bid tabulations, and by actual bids on existing plans. These curves are found in Volume 3.

KEY TO CODES USED IN EXISTING PERMIT CONDITIONS

Water Treatment Plants	n
Livestock Operations	
a) Commercial Swine Production (wco/cr No. 20,000)	e, f
b) Slaughterhouses (wco/cr No. 20,000)	e, g
c) All others	e, j
Sand & Gravel Washing Operations	
a) All with wco/cr No. 20,000)	h, k
b) Remainder	k
Thermoelectric Power Gen. Operations	l
Heavy Industrial	m
Commercial-Industrial Solids Waste Disposal	i

KEY TO CODES USED IN NPDES PERMIT CONDITIONS

	PROPOSED NPDES PERMIT CONDITIONS	COMPLIANCE SCHEDULE	
		PERMIT	COMPLETE CONST.
Water Treatment Plants	o	Dec. '74	Jan. '77
Sand & Gravel Washing Operations	p, r	-	-
	q, r	-	-
Livestock Operations	r, s	Dec. '74	Jan. '77
Thermoelectric Power Gen. Operations	r, t	Dec. '74	Jan. '77
Commercial-Industrial Solid Waste Disposal Facilities	y	-	-
Heavy Industrial	r, u	Dec. '74	Jan. '77
Except the following:			
A, T & SF Railroad	aa, r	Dec. '74	Jan. '77
Celanese	r, z	"	"
The Packs Corp.	r, v	"	"
Reichold	r, x	"	"
John Roberts	bb, b, d, r	"	"
Southwestern Graphite	r, w	"	"

CODES USED IN TABLES PRESENTING THE "PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULE FOR NPDES 1977 OBJECTIVE"

A. Construct Conventional secondary facilities.
B. Modify existing secondary facilities.
C. Expand existing secondary facilities.
D. Initiate year-round irrigation practice.
E. Expand existing irrigation operation.
F. Provide effluent to adjacent irrigated areas.
G. Construct and operate irrigation disposal facilities.
H. Modify existing irrigation operation.
I. Partial filtration, phosphorus, ammonia-nitrogen and organic nitrogen reduction.
J. Total filtration, denitrification, and further phosphorus reduction.
K. Continue total irrigation.
L. Regionalized treatment.
M. Total filtration, phosphorus, ammonia-nitrogen and organic nitrogen reduction.
N. Denitrification and further phosphorus reduction.
P. Filtration.
Q. Construct conventional secondary facilities with total filtration.
R. Nitrification, denitrification and phosphorus reduction.

a. Cl_2 residual = 0.5 mg/l after 20 minute detention time.

b. pH = 6.5 - 8.5; Fecal Coliform 200/100 ml.

c. P = 2 mg/l; NH_3N = 5 mg/l.

d. Cl_2 residual = 1.0 mg/l after 20 minute detention time.

e. No discharge of wastewater due to normal operational activity or runoff attendant to a 25-year, 24-hour rainfall.

f. As noted in "Regulation for Registration of Commercial Swine Production Waste Control Facilities" as adopted by TWQB Order No. 70-0828-4 (copy found in Appendix J of Volume 2).

g. As noted in "Regulation Concerning Meat Processing Operations and Discharges Therefrom" as adopted by TWQB Order No. 71-0429-1.

h. As noted in "Regulation Concerning Sand and Gravel Washing Operations and Discharges Therefrom" as adopted by the TWQE.

i. As noted in "Commercial-Industrial Disposal Site Regulation" as adopted by TWQB Board Order No. 71-0820-18.

j. Specific information regarding location of source, type of wastewater treatment facility, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is contained in Section V.

k. Specific information regarding location of source, type of wastewater treatment facility, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is contained in Table V-8, Section V.

l. Specific information regarding location of source, type of wastewater treatment facility, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is presented in Table V-9, Section V.

m. Specific information regarding location of source, type of wastewater treatment facility, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is presented in Table V-10, Section V.

n. Specific information regarding location of source, type of wastewater generated, existing TWQB permit conditions, quantity and quality of effluent, etc. is presented in Table V-10a of Section V.

o. No discharge with sludge treated at appropriate treatment facility.

p. No permit expected due to "no discharge" status of operation. Provisions should be made to insure the continuance of the "no discharge" status of the facility.

q. Dependent on the process and frequency of operation, two options are available.

(a) Any discharge must meet the basic effluent quality criteria and any other specific criteria established, as follows:

TSS - 20 mg/l* (All Segments except as noted below)
TSS - 5 mg/l* (Segments 1402 and 1404)**
Set. Solids - 5 ml/l*
pH range - 6.5 - 8.5
Debris - None

Toxic Compounds - None in such amounts that will cause the receiving waters to be toxic to human, animal, or aquatic life.

Foaming or Frothing Material - None in such amounts that will cause foaming or frothing of a persistent nature in the receiving waters.

(b) No discharge except for uncontaminated storm water runoff.

*Monthly average value
**Within 5 Mi. upstream from any drinking water supply intake

r. "Collected screenings, sludges, and other solids removed from water or liquid wastes shall be disposed of in such a manner as to prevent entry of such materials into the surface or ground waters of the State." In special cases where more detailed sludge disposal conditions are required, they will be set forth in the permit. (Any specific sludge disposal clauses proposed for NPDES Permits will be detailed in Segment Plans.)

s. No permit expected due to "no discharge" status of operation. (No discharge, implies no discharge of wastewater due to normal operation activity or runoff resulting from a 25-year, 24-hour rainfall.) Provisions should be made to insure the continuance of the "no discharge" status of the operation. However, if a permit is required, it should require no discharge except for uncontaminated stormwater runoff, or any runoff attendant to any rainfall of a greater magnitude than that noted above (25-year, 24-hour). If a permit is issued, the compliance schedule delineated applies.

t. The following conditions are recommended as basic to all facilities, with additional criteria specified as necessary on an individual basis:

(a) All boiler blowdown or related process water other than once-through cooling water is not to be discharged to any waters of the State.

(b) Basic effluent quality criteria:

1. Temperature: Maximum of 3 degrees F. rise over ambient temperature (when discharging to impoundments)

   Maximum of 5 degrees F. rise over ambient temperature (when discharging to a stream)

2. pH range - 6.5 - 8.5

3. No floating material

4. No foaming in immediate outfall area

u. No discharge except for uncontaminated once-through process water and uncontaminated stormwater runoff.

v. Basic effluent quality criteria as listed below (monthly average values): pH 6.5 - 8.5; Total Residue - 500 mg/l; Chloride - 50 mg/l; Sulphate- 50 mg/l; TSS - 20 mg/l; Settleable Matter - 5 ml/l; COD - 60 mg/l; Oil and Grease - 5 mg/l; Temperature - Maximum of 5 degrees F. rise above ambient stream temperature - Color - 100 APHA Units; Free or Floating Oils - None; Debris - None; Toxic Compounds - None in such amounts that will cause the receiving waters to be toxic to human, animal, or aquatic life; Foaming or Frothing Material - None in such amounts that will cause foaming or frothing of a persistent nature in the receiving waters.

w. Basic effluent quality criteria as listed below (monthly average values): pH - 6.5 - 8.5; Total Residue - 500 mg/l; Chloride - 90 mg/l; Sulphate- 75 mg/l; TSS - 5 mg/l; VSS - 2 mg/l; Settleable Matter - 5 ml/l; BOD_5- 5 mg/l; COD - 15 mg/l; Oil and Grease - 1 mg/l; Color - 50 APHA units; Temperature - Maximum of 3 degrees F. rise above ambient temperature; Iron (Fe) - 1 ppm; Manganese (Mn) - 0.2 ppm; Free or Floating Oils - None; Debris - None; Toxic Compounds - None in such amounts that will cause the receiving waters to be toxic to human, animal, or aquatic life; Foaming or Frothing Material - None in such amounts that will cause foaming or frothing of a persistent nature in the receiving waters.

x. All concentrated wastes are to be retained in lined holding ponds. Remaining process water is to be treated to a quality acceptable to the City of Austin prior to discharge into the city's sewer system.

y. No permit is expected due to the "no discharge" status of the operation. Provisions should be made to insure the continuance of the "no discharge" status of the facility. Should a permit be required, the conditions listed in the TWQB Order No. 71-0820-18, "Regulation for the Handling, Storage, and Disposal of Solid, Semi-liquid, and Liquid Wastes at Commercial-Industrial Disposal Operations," should be adhered to.

z. Basic effluent quality criteria are listed below (monthly average values): pH - 6.5 - 8.5; Total Residue - 7,000 mg/l; Chloride - 400 mg/l; Sulphate - 3,000 mg/l; TSS - 20 mg/l; VSS - 15 mg/l; Settleable Matter - 5 ml/l; BOD_5 - 20 mg/l; COD - 150 mg/l; Color-90 APHA Units; Total CR - 3 mg/l; Temperature - Maximum of 4 degrees F. rise over ambient temperature (fall, winter, and spring) or maximum of 1.5 degrees F. rise over ambient temperature (summer); Free or Floating Oil - None; Debris - None; DO - 5.0 mg/l; Toxic Compounds - None in such amounts that will cause the receiving waters to be toxic to human, animal, or aquatic life; Foaming or Frothing Material - None in such amounts that will cause foaming or frothing of a persistent nature in the receiving waters.

aa Basic effluent quality criteria are listed below (monthly average values): pH - 6.5 - 8.5; Chloride - 150 mg/l; Sulphate - 150 mg/l; Total Residue - 600 mg/l; TSS - 20 mg/l; VSS - 15 mg/l; Settleable Matter-5 ml/l; IOD - 0.5 mg/l; BOD_5 - 12 mg/l; COD - 150 mg/l; Oil and Grease - 10 mg/l; Color - 50 APHA Units; Temperature - maximum of 5 degrees F. rise over ambient temperature; Debris - None; Free or Floating Oil - None; Toxic Compounds - None in such amounts that will cause the receiving waters to be toxic to human, animal, or aquatic life; Foaming or Frothing Material - None in such amounts that will cause foaming or frothing of a persistent nature in the receiving waters.

bb BOD - 20 mg/l; TSS - 20 mg/l.

cc Cl_2 residual - 1.0 mg/l; Dissolved Oxygen - 2.0 mg/l

dd Cl_2 residual - 5.0 mg/l; Dissolved Oxygen - 4.0 mg/l

NO DIS No Discharge; all effluent to be used for irrigation and/or industrial reuse.

AD-A036 844 ARMY ENGINEER DISTRICT FORT WORTH TEX F/G 13/2

WASTEWATER MANAGEMENT PLAN. COLORADO RIVER AND TRIBUTARIES, TEX--ETC(U)

SEP 73

UNCLASSIFIED NL

5 OF 6

AD A036844

Segment Plan for Segment 1401

Description.

Colorado River Tidal

Classification.

Type - Water Quality

Reason - Violations of pH and dissolved oxygen stream standards

Note: Additional information regarding segment classification is included in Section VI.

Ranking.

Basin - 4

State - 63

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.

Heavy Industrial Operations - 1 (1 discharge)

Commercial-Industrial Solid Waste Disposal Facilities-2 (landfill)

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is included in Section V and/or the accompanying proposed Segment Effluent Limitation and Compliance Schedule for NPDES (Table VIII-4)

Non-point Sources.

Urban Runoff:

There are no communities which lie within the area tributary to this segment which have a population (1970) greater than 200. To date, there have been no known instances of pollution attributable to urban runoff in this segment.

Natural Sources:

There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oilfield Brines.

During the course of this study, the Texas Railroad Commission surveyed all oilfield activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Irrigation Return Flow.

As can be seen on Plate V-7 in Section V, irrigation return flows may be expected from irrigation sites adjacent or tributary to the segment. As detailed in Section V, two irrigation return flow sites in the vicinity of this segment operated by the Texas Water Quality Board have indicated that return flows have been of good quality and, as such, would not have a detrimental effect on the water quality of the segment.

Municipal Solid Waste Disposal Facilities.

All known municipal solid waste disposal sites within the Basin are located on Plate V-8 in Section V. There are no known facilities which are known to be creating a pollution threat to this segment.

Total Maximum Daily Loads.

In accordance with TWQB policy, all segments on which a violation of stream standards had occurred were classified as water quality limiting. The waste load analysis for this section is detailed in Section VI. Based on the results of this analysis, it is recommended that the present conditions for the Celanese Chemical Company be amended to bring the effluent into compliance with the pH stream standard for the segment.

The segment is primarily tidal due to the location of an irrigation diversion structure upstream of the segment. For a complete discussion of the segment, reference is made to Section VI.

Segment Strategy.

As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-4.

Monitoring Plan.

The segment will be monitored by the chemical, biological, and sediment station number 1401.01 located at FM 521 north of Matagorda.

Conclusions.

Segment 1401 was initially classified as water quality limited because the in-stream water was found to be in violation of the proposed stream standards, specifically the pH and DO stream standards. The violation, a pH of 8.6 and a DO of 1.7 mg/l, were monitored at TWQB Station 1414.29. Comparison of target load and existing load show no waste load allocations are required. The cause of the DO and pH violations have not been identified.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1401, it is recommended that the existing segment classification of water quality be maintained. It is also recommended that no changes to the Proposed Water Quality Standards be made.

TABLE VIII - 4

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1401 — SEGMENT DESCRIPTION: Colorado River Tidal

SEGMENT CLASSIFICATION: Water Quality Segment

INDUSTRIAL WASTE TREATMENT FACILITY

Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule: Permit	Compliance Schedule: Complete Construction
Heavy Industrial Operations						
Celanese Chemical Co.	00455	Petrochemical Plant	m	r, z	Dec 74	Jan 77
Commercial-Industrial Solid Waste Disposal (CMISWD)						
Celanese Chemical Co.	20079	CMISWD Site	i	y	–	–
Celanese Chemical Co.	20366	CMISWD Site	i	y	–	–

Note: No municipal treatment plants in this segment.

Segment Plan for Segment 1402

Description.

Colorado River - above tidal to Tom Miller Dam, including Town Lake.

Classification.

Type - Water Quality
Reason - Violations of pH stream standards

Note: Additional information regarding segment classification is included in Section VI.

Ranking.

Basin - 3
State - 56

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.

Municipal Wastewater Treatment Facilities - 22 (22 discharge)
Municipal Water Treatment Plants - 1
Livestock Operations - 17 (no discharge)
Sand and Gravel Washing Operations - 5 (2 discharge)
Thermoelectric Power Generation Operations - 2 (2 discharge)
Heavy Industrial Operations - 2 (1 discharge)

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc., is included in Section V and/or the accompanying proposed Segment Effluent Limitation and Compliance Schedule for NPDES (Table VIII-5).

Non-Point Sources.

Urban Runoff.

Urban runoff poses an eminent pollution potential to the waters of this segment, especially Town Lake. As discussed in Section V, Town Lake eventually receives most of the runoff from Austin. To date, there has been several studies indicating the apparent effect this runoff has on the Lake, which is one of the city's

drinking water supplies. In view of the past records, it is obvious that a comprehensive study of the effect of runoff on Town Lake be implemented with subsequent proposals as to how the problem may be resolved.

Natural Sources.
There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.
During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and groundwater. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Agricultural Runoff and Irrigation Return Flow.
There is extensive farming in the segment below Austin, most of which is irrigated. As seen in Plate V-7, significant return flows can be expected throughout this segment. However, as noted in Section V, these discharges do not appear to cause any significant pollution problem with regard to pesticides or herbicides. Due to the high return flows, it is recommended that the water quality monitoring network be expanded such that the effect of these return flows can be more thoroughly evaluated. This is of particular importance in view of the estuarine area downstream from the segment.

Municipal Solid Waste Disposal Facilities.
All known municipal solid waste disposal sites within the Basin are shown on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Individual Sewage Disposal Facilities.
Initially, Town Lake was constructed for municipal water supply purposes. It has become an extremely popular recreation site and, as such, has experienced extensive development around the lake. Contingent with this growth has been periodic isolated problems caused by discharge of septic tank effluent to the lake. Efforts are under way to prevent any further such discharges to the lake.

Residual Waste Disposal.

The disposal of residual waste from the City of Austin could pose a problem due to three factors:

1. The climate of the area,
2. The volume of residual waste (sludge) generated,
3. The high cost of land in the area.

In view of these factors, it would seem that proper disposal may require partial mechanical treatment of the residual waste. Only a detailed analysis of the residual waste situation can adequately assess the disposal problem if one does exist. In the remainder of the segment, the climate is apparently a primary deterent to proper air-drying of residual waste. However, air-drying is being used effectively by numerous cities in the remainder of the segment. It is recommended that the matter of residual waste disposal should be handled on an individual basis by the TWQB.

Total Maximum Daily Loads.

The basis for the segment classification was two pH violations, 8.6 and 9.5. Since these pH values were not characteristic of other readings taken at their respective stations, and they were not verified by laboratory analysis, it is recommended that the segment be reclassified to effluent limitation. (See Section VI for a further discussion of waste load allocation in this segment.) Although no DO violations were recorded, some concern was expressed as to the possibility of oxygen depletion due to the large volumes of effluent discharged to the stream. A computer simulation model was used (see details in Appendix I of Volume 2) to evaluate this matter. Using the 7-day, 10-year low flow and the respective effluent loading, there was no indication of any violation of stream standards by the permitted discharges within the segment.

Segment Strategy.

As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliances, and effluent limits for all known point sources are detailed in Table VIII-5.

Monitoring Plan.

Currently, the TWQB operates four monitoring stations in the segment (see Plate IV-5). Due to the length of the segment, nine sampling stations are designated under the proposed monitoring system. 1402.01 (currently 1401.3) is a chemical and pesticide sampling station at

U.S. 59 at Wharton. Station 1402.02 located at FM 950 at Garwood is a chemical, biological, sediment, and pesticide station. Stations 1402.03, 1402.04, and 1402.05 are chemical sampling stations located along SH 71 at Columbus, La Grange, and Smithville respectively. Station 1402.06 is located in Bastrop City Park 1/2 mile upstream from SH 71. The station will monitor chemical and biological parameters. Chemical and sediment station number 1402.07 is located at FM 973 at Del Valle. Two chemical sampling stations will monitor Town Lake. Station 1402.08 is located at Longhorn Dam while 1402.09 is at the Town Lake headwater. The USGS operates five quality monitoring stations in the segment. Two of these stations, 0815865 and 081620, are coincident with TWQB stations 1402.07 and and 1402.01, respectively. (See Plate IV-5 for location of USGS stations.)

Conclusions.

Segment 1402 was initially classified as water quality limited because the in-stream water was found to be in violation of the proposed stream standards, specifically the pH stream standard. The violations, a pH of 8.6 recorded southeast of Austin (river mile 290.3) and a pH of 9.5 recorded south of Bastrop (river mile 236.8), were not verified by laboratory analysis and were not characteristic of other readings taken during a three-year period of record within this segment. Currently, dischargers to this segment include twenty-two municipal wastewater treatment facilities and five industrial operations. Also, significant agricultural runoff and irrigation return flows can be expected below Austin. According to the mathematical model, "QUAL-1," using all projected return flow conditions and a 10-year 7-day low flow, this segment will have sufficient waste assimilative capacity to meet stream standards for DO through the planning period under existing permitted conditions.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1402, it is recommended that the existing segment classification be changed to effluent limitation. It is also recommended that no changes to the Proposed Water Quality Standards be made.

TABLE VIII-5

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT No. 1402

SEGMENT DESCRIPTION: Colorado River—Above Tidal to Tom Miller Dam
SEGMENT CLASSIFICATION: Water Quality Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit: Permit Conditions						Compliance Schedule	Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS. mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
Austin-Hornsby	10543-04	6.0	20	–		6.0 No Dis.						1-74					0
Austin-Gouldie	10543-03	40.0	20	20	d	40.0	20	20	3029.0	3029.0	b,cc	1-74					0
Austin-Williamson	10543-10	2.2	20	20		4.5	20	20	340.7	340.7	b,cc	1-74	1-76	C	1.5	8	121,800
Austin-Walnut	10543-11	2.5	20	20		18.0	20	20	1363.0	1363.0	b,cc	10-73	6-75	A	2.0	13	5,587,200
Austin-ISD	11356-01		20	20			20	20			b,cc	1-74					0
Bastrop	11076-01	.245	20	20	d	.50	20	20	37.86	37.86	b,cc	1-74	1-76	A	1.5	25	358,500
Buda	11080-01	.07	20	20	d	.07 No Dis.						1-74					0
Colorado Co. WCID No.2	10152-01	.054	24	87	d	.054 No Dis.								G	1.0	44	44,000
Columbus	10025-01	.72	90	150	d	.65	20	20	49.22	49.22	b,cc	1-74					0
Eagle Lake	10505-01	.5	20	20	d	.5 No Dis.						1-74	6-76	G	1.0	32	228,200
Eanes ISD	11010-01	.024	20	20	d	.024 No Dis.	20	20			b	1-74					0
Elgin	10100-01	.375	20	–		.375 No Dis.						1-74	6-76	G	1.0	33	244,600
Ellinger Sewer & Water	10945-01	.045	20	20	d	.045	20	20	3.41	3.41	b,cc	1-74					0
Fayetteville	10840-01	.05	20	20	d	.06	20	20	3.79	3.79	b,cc	1-74					0
Giddings—South Plant	10456-02	.1	20	58		.1 No Dis.						1-74					0
Giddings—Boys School	10456-03	.115	20	20	d	.115	20	20	8.71	8.71	b,cc	1-74					0
La Grange	10091-01	.288	26	25		.5	20	20	37.86	37.86	b,cc	10-73	10-75	A	1.0	4	358,500
Manor	11003-01	.056	20	–		.11 No Dis.						1-74	6-76	G	1.0	38	29,140
Smithville	10826-01	.525	20	20	d	.5	20	20	37.86	37.86	b,cc	1-74	1-76	A	1.5	28	358,500
Texas Highway Dept.	11299-01	.015	20	20	d	.015	20	20	1.14	1.14	b,cc	1-74					0
Weimar	10311-01	.48	20	20		.48 No Dis.	20	20			b	1-74		G	1.0	34	116,300
Wharton	10381-01	.70	20	20	d	1.5 No Dis.						1-74		B,G		6	1,499,900
SUBDIVISION AND COMPANY OWNED DOMESTIC WASTEWATER TREATMENT PLANTS																	
Scenic Brook West	11021-01	.05	20	20	d	.05	20	20	3.79	3.79	b,cc	1-74					
Country Air	11040-01	.015	20	20		.015	20	20	1.15	1.15	b,cc	1-74					
Development Assoc.	11191-01	.065	20	20	$Cl_2=2$	.065	20	20	4.92	4.92	b,cc	1-74					
Merbridge Foundation	11218-01	.026 No Dis.	20	20	d	.026 No Dis.	20	20			b	1-74					
Irene Snyder	11168-01	.01	15	20	d	.01 No Dis.	20	20			b	1-74					
Dinner Theatres Inc.	11226-01	.002 No Dis.	20	20	d	.002 No Dis.	20	20			b	1-74					

TABLE VIII - 5 (Cont'd.)

Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule Permit	Compliance Schedule Complete Construction
WATER TREATMENT PLANT						
Austin (Shoal Creek)	10543-02		n	p	–	–
LIVESTOCK OPERATIONS						
Blue Ribbon Feeders	01284	Cattle Feedlot (CF)	e, j	r, s	Dec 74	Jan 77
Ernest W. Bracewell—Southside Mkt.	20168	Slaughterhouse	e, g	r, s	Dec 74	Jan 77
Capitol Cattle Company	01734	Cattle Transfer and Holding Facility	e, j	r, s	Dec 74	Jan 77
D&D Feedlot	01592-01	CF	e, j	r, s	Dec 74	Jan 77
D&D Feedlot	01592-02	CF	e, j	r, s	Dec 74	Jan 77
Del Valle Hog Farm	20289	Commercial Swine Production (CSP)	e, f	r, s	Dec 74	Jan 77
H. W. Doyle Processing Plant	20455	Slaughter House and Meatpacking	e, g	r, s	Dec 74	Jan 77
Fayette County Swine Breeders, Inc.	20440	CSP	e, f	r, s	Dec 74	Jan 77
R. M. Heffley	20373	CSP	e, f	r, s	Dec 74	Jan 77
Kenneth Holles	01732	Dairy	e, j	r, s	Dec 74	Jan 77
J. S. Ranch, Inc.	20018	CSP	e, f	r, s	Dec 74	Jan 77
Noel G. Lawson	20009	CSP	e, f	r, s	Dec 74	Jan 77
Long & Pittman	20123	CSP	e, f	r, s	Dec 74	Jan 77
Sansom & Sons Dairy	01574	Dairy	e, j	r, s	Dec 74	Jan 77
Texas Rendering Co., Inc.	20329	Rendering Plant	e, g	r, s	Dec 74	Jan 77
Ralph Voss	20476	CSP	e, f	r, s	Dec 74	Jan 77
Windy Hill Farm	20351	CSP	e, f	r, s	Dec 74	Jan 77

TABLE VIII - 5 (Cont'd.)

Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule Permit	Compliance Schedule Complete Construction
SAND AND GRAVEL WASHING OPERATIONS						
Capitol Aggregates, Inc.	00486-01	Asphaltic Concrete Plant	k	q, r	Dec 74	Jan 77
Capitol Aggregates, Inc.	00486-02	Ready-mix Concrete Plant	k	q, r	Dec 74	Jan 77
Capitol Aggregates, Inc.	00487	Sand and Gravel Washing	k	q, r	Dec 74	Jan 77
Elgin-Butler Brick Co.	00444	Brick and Tile Manufacturing	k	p, r	Dec 74	Jan 77
Elgin-Butler Brick Co.	01414	Manufacture Structural Clay Products	k	p, r	Dec 74	Jan 77
Gifford-Hill and Co., Inc.	01328	S&GW	k	q, r	Dec 74	Jan 77
Longhorn Sand and Gravel, Inc.	00775	S&GW	k	q, r	Dec 74	Jan 77
Southwest Materials, Inc.	20247	S&GW	h, k	q, r	Dec 74	Jan 77
THERMOELECTRIC POWER GENERATION OPERATIONS						
City of Austin (Seaholm Power Plant)	10543-05	Power Plant	l	r, t	Dec 74	Jan 77
City of Austin (Holly Street Power Plant)	10543-06	Power Plant	l	r, t	Dec 74	Jan 77
HEAVY INDUSTRIAL OPERATIONS						
Reichhold Chemicals, Inc.	01364	Chemical Manufacturing	m	r, x	Dec 74	Jan 77
John Roberts, Inc.	01258	Jewelry Manufacturing	m	bb, r, b, d	Dec 74	Jan 77

Segment Plan for Segment 1403

Description.

Lake Austin

Classification.

Type - Water Quality

Reason - So classified due to lack of sufficient data.

Note: Additional information regarding segment classification is included in Section VI.

Ranking.

Basin - 9

State - 137

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.

Municipal Water Treatment Plants 2 (2 discharge)

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is included in Section V and/or the accompanying proposed Segment Effluent Limitation and Compliance Schedule for NPDES (Table VIII-6).

Non-Point Sources.

Urban Runoff.

Of the communities which lie within the area tributary to this segment and have a population (1970) greater than 200, none have a defined stormwater sewer system. To date, there have been no known instances of pollution attributable to urban runoff from the developments surrounding the lake.

Natural Sources.

There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.

During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Irrigation Return Flow.

There are no irrigation return flows to this segment.

Municipal Solid Waste Disposal Facilities.

All known municipal solid waste disposal sites within the Basin are shown on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Total Maximum Daily Loads.

In accordance with TWQB policy, all segments which had insufficient data to positively define the segment as effluent limitation were classified as water quality limiting until such time as adequate data were available to verify the designation. Designation of this segment as water quality limiting does not indicate that any violation of stream standards has occurred or will occur. Therefore, waste load allocations are not justified for this segment at this time.

Segment Strategy.

As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliances, and effluent limits for all known point sources are detailed in Table VIII-6.

Monitoring Plan.

The segment will be monitored by three chemical sampling stations: station 1403.01 near Tom Miller Dam, station 1403.02 near Metropolitan Park, and station 1403.03 near the headwater at Lakeland Park.

Conclusions.

Segment 1403 was initially classified as water quality limited due to insufficient data to verify either compliance with or violation of the proposed stream standards. During this study, no known instances of pollution attributable to urban runoff, natural sources, or oil field brines were revealed. Also, there are no irrigation return flows to this segment. The waters of this segment are being used for domestic raw water supplies and contact and non-contact

recreation, and are also supporting the propagation of fish and wildlife. There are no known instances of contamination or pollution in this segment that would prevent the continued use of these waters for the above-stated purposes. Information furnished by the TSDH reveals that water from this segment is used as a domestic raw water supply for the City of Austin, Cedar Park Water Supply Corporation, Creedmore-Maha Water Supply Corporation, Lake Austin Lodges, Rivercrest Addition, Hidden Valley, P. M. Hargis Mobile Home Park, and Willow Bend Mobile Home Park. Therefore, although no formal data are currently available, the TSDH approval of this segment for use as a domestic raw water supply indicates the acceptable quality of the waters. It is believed that the proposed TWQB monitoring program will further substantiate the acceptable quality of the water in this segment. Under the proposed NPDES permit system, there is only one discharger to this segment.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1403, it is recommended that the existing segment classification be changed to effluent limitation. It is also recommended that no changes to the Proposed Water Quality Standard be made.

TABLE VIII - 6

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1403

SEGMENT DESCRIPTION: Lake Austin

SEGMENT CLASSIFICATION: Water Quality Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit: Permit Conditions						Proposed NPDES Permit: Compliance Schedule	Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs	Basin Priority	Estimated Capital Cost
St. Stephens Episcopal School (Privately owned domestic wastewater treatment plant)	11202-01	.015	20			.015	5	5	0.28	0.28	b, c, dd						

Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule: Permit	Compliance Schedule: Complete Construction
WATER TREATMENT PLANTS						
Austin (Hucks Slough)	10543-01		n	o	Dec 74	Jan 77
Rivercrest Addition	10713		n	o	Dec 74	Jan 77

Segment Plan for Segment 1404

Description.

Lake Travis

Classification.

Type - Water Quality

Reason - So classified due to lack of sufficient data.

Note: Additional information regarding segment classification is included in Section VI.

Ranking.

Basin - 8

State - 115

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.

Municipal wastewater treatment plants	- 6 (3 discharge)
Municipal water treatment plants	- 3
Livestock operation	- 2 (no discharge)
Sand and gravel washing operations	- 1 (1 discharge)

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is included in Section V and/or the accompanying proposed segment effluent limitation and compliance schedule for NPDES (Table VIII-7).

Non-Point Sources.

Urban Runoff.

Of the communities which lie within the area tributary to this segment and have a population (1970) greater than 200, none have a defined stormwater sewer system. The largest of the communities has a population (1970) of 2,864. To date, there have been no known instances of pollution attributable to urban runoff from these areas.

Natural Sources.
There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.
During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Irrigation Return Flow.
There are no irrigation return flows to this segment.

Municipal Solid Waste Disposal Facilities.
All known municipal solid waste disposal sites within the Basin are shown on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Residual Waste Disposal.
Due to the arid nature of the climate for the segment, air-drying of residual sludges with ultimate disposal as fertilizer or in a land fill is the most efficient and practical method of disposal. No contamination of segment waters has been associated with residual wastes.

Total Maximum Daily Loads.
In accordance with TWQB policy, all segments which had insufficient data to positively define the segment as effluent limitation were classified as water quality limiting until such time as adequate data were available to verify the designation. Designation of this segment as water quality limiting does not indicate that any violation of stream standards has occurred or will occur. Therefore, waste load allocations are not justified for this segment at this time.

Segment Strategy.
As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-7.

Monitoring Plan.

The segment will be monitored by six chemical stations. The stations are 1404.01 near Mansfield Dam at the LCRA Travis County Park, 1404.02 at the Big Sandy Creek Arm, 1404.03 near Lakeway, 1404.04 at the Pedernales River Arm, 1404.05 above the confluence of the Pedernales River, and 1404.06 near Spicewood.

Conclusions.

Segment 1404 was initially classified as water quality limited due to insufficient data to verify either compliance with or violation of the proposed stream standards. During this study, no known instances of pollution attributable to urban runoff, natural sources, or oil field brines were revealed. Also, there are no irrigation return flows to this segment. The waters of this segment are being used for domestic raw water supplies, industrial water supply and contact and non-contact recreation, and are also supporting the propagation of fish and wildlife. There are no known instances of contamination or pollution in this segment that would prevent the continued use of these waters for the above-stated purposes. Information furnished by the TSDH reveals that water from this segment is used as a domestic raw water supply for Lakeway Inn and Marina, Travis County WCID No. 17, Lago Vista, Lakeside Beach Subdivision, North Shore Colonies, Point Venture, and Blackie Moore's Marina. Therefore, although no formal data are currently available, the TSDH approval of this segment for use as a domestic raw water supply indicates the acceptable quality of the waters. It is believed that the proposed TWQB monitoring program will further substantiate the acceptable quality of the water in this segment. All dischargers are limited under the proposed NPDES permits to "no-discharge" conditions as dictated by the "most cost effective" treatment process to meet requirements of PL 92-500.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1404, it is recommended that the existing segment classification be changed to effluent limitation. It is also recommended that no changes to the Proposed Water Quality Standard be made.

TABLE VIII - 7

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1404 **SEGMENT DESCRIPTION:** Lake Travis

SEGMENT CLASSIFICATION: Water Quality Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit: Permit Conditions						Compliance Schedule	Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
Burnet	10793-01	.475	20	20		.475 No Dis.						1-74					0
Lakeway MUD No. 1 * Inn and Marina	10531-01	.100	20	20		1.1 No Dis.	20	20			b	1-74	1-76	A	1.0	14	639,900
Lakeway MUD No. 1 * Lake Travis Townhouses	11151-01	.01	20	20													
Lakeway MUD No. 1 * World of Tennis	11281-01	.175 No Dis.	20	20													
Lakeway MUD No. 1 *	11322-01		20	20													
Travis Co. WCID Point Venture	11232-01	.036 No Dis.	20	20		.10 No Dis.	20	20			b	1-74	1-76	K	1.0	15	157,580
Travis Co. MUD No. 1 (Lago Vista)	11224	.07 No Dis.	20	20		1.0 No Dis.	20	20			b	1-74	1-76	A,G	1.5	16	846,000
SUBDIVISION AND COMPANY OWNED DOMESTIC WASTEWATER TREATMENT PLANTS																	
Lake Travis Townhouse	11151	.01 No Dis.	20	20	d	.01 No Dis.	20	20			b	1-74					
Pedernales Country Club	10892	.01	20	20		.01 No Dis.	20	20			b	1-74					

* To be combined into regional treatment plant for the Lakeway area.

TABLE VIII - 7 (Cont'd.)

Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule	
					Permit	Complete Construction
WATER TREATMENT PLANTS						
Burnet	10793-01		n	o	Dec 74	Jan 77
Lakeway Inn and Marina	10531-02		n	o	Dec 74	Jan 77
Travis Co. WCID No. 17	10468		n	o	Dec 74	Jan 77
LIVESTOCK OPERATIONS						
Jerome K. Felps	20062	Commercial Swine Production (CSP)	e, f	r, s	Dec 74	Jan 77
M. O. Scott	20028	CSP	e, f	r, s	Dec 74	Jan 77
SAND AND GRAVEL WASHING OPERATIONS						
Lone Star Industries, Inc.	00841	Limestone Processing Plant	k	q, r	Dec 74	Jan 77

Segment Plan for Segment 1405

Description.
Lake Marble Falls

Classification.
Effluent Limitation

Note: Additional information regarding segment classification is included in Section VI.

Ranking.
Basin - 19
State - 240

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.
Municipal Wastewater Treatment Plant - 1 (1 discharge)
Municipal Water Treatment Plant - 1

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is included in Section V and/or the accompanying proposed Segment Effluent Limitation and Compliance Schedule for NPDES (Table VIII-8).

Non-Point Sources.

Urban Runoff.
Of the communities which lie within the area tributary to this segment and have a population (1970) greater than 200, none have a defined stormwater sewer system. To date, there have been no known instances of pollution attributable to urban runoff from these areas.

Natural Sources.
There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.

During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Irrigation Return Flow.

There are no irrigation return flows to this segment.

Municipal Solid Waste Disposal Facilities.

All known municipal solid waste disposal sites within the Basin are located on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Residual Waste Disposal.

Note: Due to the arid nature of the climate for the segment, air-drying of residual sludges with ultimate disposal as fertilizer or in a landfill is the most efficient and practical method of disposal. No contamination of segment waters has been associated with residual wastes.

Total Maximum Daily Loads.

Note: Total maximum daily loads are not applicable to effluent limitation segments since, by definition, conformance to the national goals of best practicable waste treatment technology for industry and secondary treatment of domestic wastewater by municipalities will not result in a violation of the stream standards for this segment.

Segment Strategy.

As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-8.

Monitoring Plan.

The segment will be monitored by two chemical sampling stations. Station 1405.01 is near Max Starcke Dam, while Station 1405.02 is near U.S. Highway 281.

Conclusions.

Segment 1405 was classified effluent limitation because the water quality within this segment is better than applicable water quality standards and will continue to be better after the application of best practicable control technology for industry and secondary treatment for municipalities. During this study, no known instances of pollution attributable to urban runoff, natural sources, or oil field brines were revealed. Also, there are no irrigation return flows to this segment. As in other effluent limitation segments, the water is deemed suitable for all its designated uses.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1405, it is recommended that the existing segment classification of effluent limitation be maintained. It is also recommended that no changes to the Proposed Water Quality Standards be made.

TABLE VIII - 8

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1405

SEGMENT DESCRIPTION: Lake Marble Falls

SEGMENT CLASSIFICATION: Effluent Limitation Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit: Permit Conditions						Proposed NPDES Permit: Compliance Schedule	Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
Marble Falls WCID No. 1	10654-02	0.24	20	20		.24	5	5	4.54	4.54	b, c, dd	1-74	6-76	A	1.0	85	44,500

					Compliance Schedule	
Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Permit	Complete Construction
WATER TREATMENT PLANT						
Marble Falls WCID No. 1	10654-02		n	o	Dec 74	Jan 77

Segment Plan for Segment 1406

Description.

Lake Lyndon B. Johnson

Classification.

Type - Water Quality

Reason - So classified due to lack of sufficient data

Note: Additional information regarding segment classification is included in Section VI.

Ranking.

Basin - 12

State - 140

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.

Municipal Wastewater Treatment Plant - 1 (no discharge)

Municipal Water Treatment Plant - 2

Livestock Operation - 1 (no discharge)

Thermoelectric Power Generation -

Construction of a major power generation facility has been initiated adjacent to this segment. The facility has received a discharge permit from TWQB (01369) subject to the results of an extensive ecological study.

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is included in Section V and/or the accompanying proposed Segment Effluent Limitation and Compliance Schedule for NPDES (Table VIII-9).

Non-Point Sources.

Urban Runoff.

Of the communities which lie within the area tributary to this segment and have a population (1970) greater than 200, none have a defined stormwater sewer system. To date, there have been no known instances of pollution attributable to urban runoff from these areas.

Natural Sources.
There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.
During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Irrigation Return Flow.
There are no irrigation return flows to this segment.

Municipal Solid Waste Disposal Facilities.
All known municipal solid waste disposal sites within the Basin are located on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Total Maximum Daily Loads.
In accordance with TWQB policy, all segments which had insufficient data to positively define the segment as effluent limitation were classified as water quality limiting until such time as adequate data were available to verify the designation. Designation of this segment as water quality limiting does not indicate that any violation of stream standards has occurred or will occur. Therefore, waste load allocations are not justified for this segment at this time.

Segment Strategy.
As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-9.

Monitoring Plan.
The segment will be monitored by three chemical sampling stations. Station 1406.01 is near Alvin Wirtz Dam, 1406.02 is near Sherwood Shores, and 1406.03 is near Kingsland at the lake's headwater.

Conclusions.

Segment 1406 was initially classified as water quality limited due to insufficient data to verify either compliance with or violation of the proposed stream standards. During this study, no known instances of pollution attributable to urban runoff, natural sources, or oil field brines were revealed. Also, there are no irrigation return flows to this segment. The waters of this segment are being used for domestic raw water supplies, industrial water supply, and contact and non-contact recreation, and are also supporting the propagation of fish and wildlife. There are no known instances of contamination or pollution in this segment that would prevent the continued use of these waters for the above-stated purposes. Information furnished by the Texas State Department of Health reveals that water from this segment is used as a domestic raw water supply for Belknap Water Works, Blue Lake Estates, Deer Haven, Hanning Water System, Horseshoe Bay, Kingsland Water Company, Sunrise Beach, and Sandy Harbor. Therefore, although no formal data are currently available, the TSDH approval of this segment for use as a domestic raw water supply indicates the acceptable quality of the waters. It is believed that the proposed TWQB monitoring program will further substantiate the acceptable quality of the water in this segment. All dischargers are limited under the proposed NPDES permits to "no-discharge" conditions as dicated by the "most cost effective" treatment process to meet requirements of PL 92-500.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1406, it is recommended that the existing segment classification be changed to effluent limitation. It is also recommended that no changes to the Proposed Water Quality Standards be made.

TABLE VIII - 9

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1406

SEGMENT DESCRIPTION: Lake Lyndon B. Johnson

SEGMENT CLASSIFICATION: Water Quality Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit: Permit Conditions						Compliance Schedule	Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
Lake LBJ MUD No. 1 (Improvement Corp.) Horseshoe Bay)	11217-01	0.10 No Dis.	20	20		.10 No Dis.	20	20			b	1-74					0

Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule: Permit	Complete Construction
WATER TREATMENT PLANTS						
D. R. Belknap	10830		n	o	Dec 74	Jan 77
Sunrise Beach	10752		n	o	Dec 74	Jan 77
LIVESTOCK OPERATION						
Edgar J. Moss	20035	Commercial Swine Production	e, f	r, s	Dec 74	Jan 77

Segment Plan for Segment 1407

Description.
Inks Lake

Classification.
Type - Water Quality
Reason - So classified due to lack of sufficient data

Note: Additional information regarding segment classification is included in Section VI.

Ranking.
Basin - 11
State - 139

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.
Heavy Industrial Operation - 1 (1 discharge)

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is included in Section V and/or the accompanying Proposed Segment Effluent Limitation and Compliance Schedule for NPDES (Table VIII-10).

Non-Point Sources.

Urban Runoff.
There are no communities which lie within the area tributary to this segment that have a population (1970) greater than 200 or have a defined stormwater sewer system. To date, there have been no known instances of pollution attributable to urban runoff to this segment.

Natural Sources.
There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.

During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Irrigation Return Flow.

There are no irrigation return flows to this segment.

Municipal Solid Waste Disposal Facilities.

All known municipal solid waste disposal sites within the Basin are located on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Total Maximum Daily Loads.

In accordance with TWQB policy, all segments which had insufficient data to positively define the segment as effluent limitation were classified as water quality limiting until such time as adequate data were available to verify the designation. Designation of this segment as water quality limiting does not indicate that any violation of stream standards has occurred or will occur. Therefore, waste load allocations are not justified for this segment at this time.

Segment Strategy.

As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-10.

Monitoring Plan.

The segment will be monitored by chemical stations 1407.01 (near Inks Dam), 1407.02 (at the Clear Creek Arm), and 1407.03 (at State Highway 29 at the headwater).

Conclusions.

Segment 1407 was initially classified as water quality limited due to insufficient data to verify either compliance with or violation of the proposed stream standards. During this study, no known instances of pollution attributable to urban runoff, natural sources, or oil field brines were revealed. Also, there are no irrigation return flows to this segment. The waters of this segment are being used for domestic raw water supplies, industrial water supply and contact and non-contact recreation and are also supporting the propagation

of fish and wildlife. There are no known instances of contamination or pollution in this segment that would prevent the continued use of these waters for the above-stated purposes. Information furnished by the TSDH reveals that water from this segment is used as a domestic raw water supply for Inks Lake State Park and Inks Lake Village No. 1. Therefore, although no formal data are currently available, the TSDH approval of this segment for use as a domestic raw water supply indicates the acceptable quality of the waters. It is believed that the proposed TWQB monitoring program will further substantiate the acceptable quality of the water in this segment. There is only one discharger to this segment.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1407, it is recommended that the existing segment classification be changed to effluent limitation. It is also recommended that no changes to the Proposed Water Quality Standard be made.

TABLE VIII - 10

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1407

SEGMENT DESCRIPTION: Inks Lake

SEGMENT CLASSIFICATION: Water Quality Segment

Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule Permit	Compliance Schedule Complete Construction
HEAVY INDUSTRIAL OPERATION						
Southwestern Graphite Co.	00360	Graphite Mining and Extracting	m	r, w	Dec 74	Jan 77

Note: No municipal treatment plants in this segment.

Segment Plan for Segment 1408

Description.
Lake Buchanan

Classification.
Type - Water Quality
Reason - So classified due to lack of sufficient data.

Note: Additional information regarding segment classification is included in Section VI.

Ranking.
Basin - 10
State - 138

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.
Municipal Water Treatment Plant - 1

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is included in Section V and/or the accompanying proposed Segment Effluent Limitation and Compliance Schedule for NPDES (Table VIII-11).

Non-Point Sources.

Urban Runoff.
No communities lying within the area tributary to this segment and having a population (1970) greater than 200 have a defined stormwater sewer system. To date, there have been no known instances of pollution attributable to urban runoff from these areas.

Natural Sources.
There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.
During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Irrigation Return Flow.
There are no irrigation return flows to this segment.

Municipal Solid Waste Disposal Facilities.
All known municipal solid waste disposal sites within the Basin are located on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Total Maximum Daily Loads.
In accordance with TWQB policy, all segments which had insufficient data to positively define the segment as effluent limitation were classified as water quality limiting until such time as adequate data were available to verify the designation. Designation of this segment as water quality limiting does not indicate that any violation of stream standards has occurred or will occur. Therefore, waste load allocations are not justified for this segment at this time.

Segment Strategy.
As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-11.

Monitoring Plan.
The segment will be monitored by chemical sampling stations 1408.01 near Buchanan Dam, 1408.02 at the Morgan Creek arm, and 1408.03 near the lake's headwater.

Conclusions.
Segment 1408 was initially classified as water quality limited due to insufficient data to verify either compliance with or violation of the proposed stream standards. During this study, no known instances of pollution attributable to urban runoff, natural sources, or oil field brines were revealed. Also, there are no irrigation return flows to this segment. The waters of this segment are being used for domestic raw water supplies and contact and non-contact recreation, and are also supporting the propagation of fish and wildlife. There

are no known instances of contamination or pollution in this segment that would prevent the continued use of these waters for the above-stated purposes. Information furnished by the TSDH reveals that water from this segment is used as a domestic raw water supply for Paradise Point Water Supply Corporation and Golden Beach. Therefore, although no formal data are currently available, the TSDH approval of this segment for use as a domestic raw water supply indicates the acceptable quality of the waters. It is believed that the proposed TWQB monitoring program will further substantiate the acceptable quality of the water in this segment. There are no dischargers to this segment.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1408, it is recommended that the existing segment classification be changed to effluent limitation. It is also recommended that no changes to the Proposed Water Quality Standard be made.

TABLE VIII - 11

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1408

SEGMENT DESCRIPTION: Lake Buchanan

SEGMENT CLASSIFICATION: Water Quality Segment

Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule	
					Permit	Complete Construction
WATER TREATMENT PLANT						
Paradise Point Water Supply Corp.	10929		n	p		

Note: No municipal treatment plants in this segment.

Segment Plan for Segment 1409

Description.
Colorado River-Lake Buchanan headwater to San Saba River confluence.

Classification.
Effluent Limitation.

Note: Additional information regarding segment classification is included in Section VI.

Ranking.
Basin - 22
State - 266

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.
There are no known point sources of pollution within the area tributary to this segment. The only community within the segment, Lometa, does not have a sanitary collection and treatment system.

Non-Point Sources.

Urban Runoff.
Only one community, Lometa (population 623), lies within the area tributary to this segment, The community does not have a defined stormwater sewer system. To date, there have been no known instances of pollution attributable to urban runoff from this area.

Natural Sources.
There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.
During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both

surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Irrigation Return Flow.

As can be seen on Plate V-7 in Section V, irrigation return flows may be expected from irrigation sites adjacent or tributary to the segment. No evidence is known to indicate that this return flow would have a detrimental effect on the water quality of the segment.

Municipal Solid Waste Disposal Facilities.

All known municipal solid waste disposal sites within the Basin are located on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Total Maximum Daily Loads.

Total maximum daily loads are not applicable to effluent limitation segments since, by definition, conformance to the national goals of best practicable waste treatment technology for industry and secondary treatment of domestic wastewater by municipalities will not result in a violation of the stream standards for this segment.

Segment Strategy.

Not applicable, since there are no known point sources contributory to the segment.

Monitoring Plan.

The segment will be monitored by the chemical, pesticide, and biological sampling station 1409.01 (formerly 1401.36) at U.S. 190 east of San Saba.

Conclusions.

Segment 1409 was classified effluent limitation because the water quality within this segment is better than applicable water quality standards and will continue to be better after the application of best practicable control technology for industry and secondary treatment for municipalities. During this study, no known instances of pollution attributable to urban runoff, natural sources, or oil field brines were revealed. Although irrigation return flows may be expected from irrigation sites adjacent or tributary to this segment, no evidence is known to indicate that this return flow would have a detrimental effect on the water quality of this segment. As in other effluent limitation segments, the water is deemed suitable for all its designated uses.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1409, it is recommended that the existing segment classification of effluent limitation be maintained. It is also recommended that no changes to the Proposed Water Quality Standards be made.

Segment Plan for Segment 1410

Description.

Colorado River-San Saba River confluence to E. V. Spence Reservoir (Robert Lee Dam)

Classification.

Type - Water Quality
Reason - Violation of Total Dissolved Solids (TDS) Stream Standards.

Note: Additional information regarding segment classification is included in Section VI.

Ranking.

Basin - 7
State - 87

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.

Municipal wastewater treatment plants	- 7 (5 discharge)
Municipal water treatment plants	- 6
Livestock operations	- 4 (no discharge)
Sand and gravel operations	- 2 (no discharge)
Thermoelectric power generation operations	- 1 (1 discharge)

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc., is included in Section VIII and/or the accompanying proposed segment effluent limitations and compliance schedule for NPDES (Table VIII-12).

Non-Point Sources.

Of the nine communities which lie within the area tributary to this segment and have a population (1970) greater than 200, three have a defined stormwater sewer system. The largest of the communities, Ballinger, has a population (1970) of 4,203. To date, there have been no known instances of pollution attributable to urban runoff from these areas.

Natural Sources and Oil Field Brines.

The closure of Robert Lee Dam has resulted in a significant reduction in the inflow of highly saline water from the upstream segments. This is aptly evidenced by the fact that the total dissolved solids concentration in E. V. Spence Reservoir averages around 560 mg/l. The primary source of salt contamination at present appears to be numerous unplugged saltwater-producing oil wells within the segment. In fact, there are two leaking wells upstream from the station where the TDS violation was monitored--one located on the bank of the Colorado River. Approximately 27 wells were found to be leaking or seeping saltwater in Segment 1410. These problems were uncovered during an investigation of all oil and gas fields conducted by the Texas Railroad Commission as of 19 October 1972. The following violations of Railroad Commission rules were uncovered during the investigation:

1. Accidental spills of oil and saltwater due to equipment failure or careless operation.
2. Unauthorized pits being used for saltwater disposal.
3. Saltwater escaping from tanks and flow lines.
4. Saltwater seeping at the surface.
5. Saltwater flowing out of unplugged wells.

According to the Texas Railroad Commission, all operational problems have been corrected, all pit use has been eliminated and all oil or saltwater spills cleaned up.

The following is a list of wells which were found leaking or seeping saltwater:

1.	Runnels Co. 6 mi NE of Ballinger, Texas	Estimated 1260 gals/day of saltwater flowing	Approved for plugging
2.	Runnels Co. 7 mi NE of Winters, Texas	Saltwater seep at surface	Approved for plugging
3.	Runnels Co. near Maverick, Texas	Flow shut off at top of well	Referred to Attny. Gen. 10-8-71

4.	Coke Co. 9 mi ESE of Robert Lee, Texas on bank of river	Slight flow of saltwater	Referred to Attorney Gen. 4-10-70
5.	Coke Co. 5 mi. SE of Robert Lee, Texas	Slight flow of saltwater	Approved for plugging
6.	Mills Co. 5 mi. from river-southwest part	Flowing 3150 gal/day 1200 ppm chloride	Plugging requested
7.	Mills Co. 2 mi. from river-southwest part	Flowing 2520 gal/day 2680 ppm chloride	Plugging requested
8.	Mills Co. on Colorado River-southeast part	Flowing 3150 gal/day 1120 ppm	Plugging requested
9.	Coleman Co. - Old Pioneer Field	19 wells which could be the cause of a very large seep area nearby	4 wells recently plugged by State

The extent of the problem is more apparent upon review of the Railroad Commission of Texas' report in Appendix D of Volume 2.

Agricultural Runoff and Irrigation Return Flow.

As can be seen on Plate V-7 in Section 5, irrigation return flows may be expected from irrigation sites adjacent or tributary to the segment. No evidence is known to indicate that this return flow would have a detrimental effect on the water quality of the segment.

Municipal Solid Waste Disposal Facilities.

All known municipal solid waste disposal sites within the Basin are located on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Residual Waste Disposal.

Air-drying of sludges on sludge drying beds has proven acceptable in this area. The residue from the beds is removed to a landfill or used as fertilizer. Residual waste disposal does not pose any significant problem in this area.

Total Maximum Daily Loads.

A waste load analysis was performed to determine the maximum daily loads, and as noted in Section VI the existing load, 1,463 lbs/day, notably exceeded the segment target load of 674 lbs/day. As noted in Section VI, it is not reasonable that the municipal facilities were or are responsible for the violations. Further, it should be noted that sufficient data were not available to permit inclusion of loads from the two leaking oil wells. Prior to any specific waste load allocation an in-depth survey should be made to ascertain the source of the TDS between Robert Lee Dam and TWQB Station 103.37 on U.S. Hwy 277 south of Bronte.

Segment Strategy.

As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-12.

Monitoring Plan.

The USGS maintains several water quality monitoring stations (see Plate III-1) in the segment. Two of the USGS stations, 081625 and 081380, are coincident with two TWQB stations, 1403.12 and 1402.11, respectively. In addition to the two above stations, the TWQB also currently maintains a monitoring station, 1403.37, on U.S. Hwy 277 south of Bronte, and one on Elm Creek at the Ballinger City Park (1400.41). The TWQB plans to delete stations 1403.37, with the remaining stations to be numbered as follows:

Current No.	Proposed No.
1403.37	Deleted
1400.41	1400.06
1403.12	1410.02
1402.11	1410.01

It is again noted that a survey should be conducted between Robert Lee Dam and station 1403.37 to determine the source of the high TDS.

Conclusions.

Segment 1410 was initially classified as water quality limited because the in-stream water was found to be in violation of the proposed stream standards, specifically the TDS stream standard. The primary violation, a yearly average TDS of 1500 mg/l, was recorded at TWQB Station 1403.37 south of Bronte. Leaking oil wells are the apparent source of TDS problems. All municipal dischargers are below the point of violation.

Recommendations:

Based on the preceding discussion of existing conditions in Segment 1410, it is recommended that the existing segment classification be changed to effluent limitation. It is also recommended that no changes to the Proposed Water Quality Standard be made.

TABLE VIII - 12

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1410

SEGMENT DESCRIPTION: Colorado River-San Saba River Confluence to E. V. Spence Reservoir

SEGMENT CLASSIFICATION: Water Quality Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit: Permit Conditions						Proposed NPDES Permit: Compliance Schedule	Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
Ballinger	10325	.28	20	125		.34 No Dis.						1-74	1-76	B,G	1.0	7	380,000
Bangs	10122	.048	20	20		.048	20	20	3.63	3.63		1-74	6-76	A	1.0	31	167,000
Bronte	10380	– No Dis.	20	–		.07 No Dis.											
Goldthwaite	10488	.17 No Dis.	–	–		.16 No Dis.						10-73	10-75	K	1.0	2	193,100
Robert Lee	10803	.212	20	20	a	.10	20	20	7.57	7.57	b						
Santa Anna	10274	.15	20	20		.15 No Dis.						1-74	6-76	G	1.0	70	91,000
Winters	10320	.16	85	120		.16	20	20	12.12	12.12	b	1-74	1-76	A	1.0	12	223,000

TABLE VIII - 12 (Cont'd.)

Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule: Permit	Compliance Schedule: Complete Construction
WATER TREATMENT PLANT						
Ballinger	10326-02		n	o	Dec 74	Jan 77
Bronte	10390-02		n	p		
Goldthwaite	10459-02		n	o	Dec 74	Jan 77
Robert Lee	10803-01		n	p		
Talpa	10759		n	o	Dec 74	Jan 77
Winters	10320-03		n	p		
LIVESTOCK OPERATIONS						
Beakley Bros. Enterprises	20063	Commercial Swine Production (CSP)	e, f	r, s	Dec 74	Jan 77
Gene Doss Feedlot	20249	CSP	e, f	r, s	Dec 74	Jan 77
Strube Market and Locker	20463	Slaughterhouse and Meat Market	e, g	r, s	Dec 74	Jan 77
Win-Tex Cattle Feeders, Inc.	01388	Cattle Feedlot	e, j	r, s	Dec 74	Jan 77
SAND AND GRAVEL WASHING OPERATIONS						
Bryan's Concrete Co.	20328	Sand and Gravel Washing (S&GW)	h, k	p, r		
W. L. Johnson Sand and Gravel Co.	00764	S&GW	k	q, r	Dec 74	Jan 77
THERMOELECTRIC POWER GENERATION OPERATIONS						
West Texas Utilities Co.						
Oak Creek Reservoir Outlet 1	00997-01	Power Generation	l	r, t	Dec 74	Jan 77
Outlet 2	00997-02-05	Power Generation	l	r, t	Dec 74	Jan 77
Outlet 3	00997-06	Power Generation	l	r, t	Dec 74	Jan 77

Segment Plan for Segment 1411

Description.
E. V. Spence Reservoir

Classification.
Effluent Limitation

Note: Additional information regarding segment classification is included in Section VI.

Ranking.
Basin - 21
State - 265

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.
There are no point sources which discharge to the reservoir proper.

Non-Point Sources.

Urban Runoff.
There are several population concentrations located upstream; however, there has been no known evidence of the urban runoff from these towns causing degradation of the reservoir. More details concerning urban runoff in the upstream segment can be reviewed in the "Segment Plan for Segment 1412."

Natural Source and Oil Field Brines.
Undoubtedly, the most prominent potential source of pollution or contamination to the reservoir is the inflow from the upstream segment. As outlined in the "Segment Plan for Segment 1412," the so-called "salt problem" has caused notable degradation of the river at times. In an effort to protect E. V. Spence from these highly saline inflows, a low-flow diversion structure has been constructed to divert the highly saline low flows to an off-channel reservoir. To date, the structure has proven fairly effective. Continuing effort must be maintained to protect the lake from these highly saline inflows from the upstream segment.

Agricultural Runoff and Irrigation Return Flow.

There is only limited farming in the area, and there is very little possibility of any runoff or return flow. Thus, these flows are not considered significant pollution sources in this segment.

Municipal Solid Waste Disposal Facilities.

All known municipal solid waste disposal sites within the Basin are located on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Individual Sewage Disposal Facilities.

There is little development around the lake and this condition is not expected to change notably during the study period. Consequently, septic tanks do not appear to present a serious pollution threat to the lake. Regardless, continuing efforts should be taken to insure the continued use of this reservoir as a municipal water supply.

Residual Waste Disposal.

Due to the arid climate of the area, air-drying of sludge on sludge drying beds is highly desirable. The residue from the beds is removed to a landfill or used as fertilizer. Waste disposal does not pose any significant problem in this area.

Total Maximum Daily Loads.

Total maximum daily loads are not applicable to effluent limitation segments since, by definition, conformance to the national goals of best practicable waste treatment technology for industry and secondary treatment of domestic wastewater by municipalities will not result in a violation of the stream standards for this segment.

Segment Strategy.

As indicated, there are no known point sources which discharge to the segment. The primary point of interest is inflow from the upstream segment. The Colorado River Municipal Water District owns E. V. Spence Reservoir and the low-flow diversion works. The District is actively engaged in protecting the water of the reservoir from contamination as the result of highly saline inflows. Obviously, the efforts should be vigorously continued.

Monitoring Plan.

The existing monitoring station 1404.13 (1411.01 under the proposed system) located at the south end of the dam will continue to monitor this segment.

Conclusions.

Segment 1411 was classified effluent limitation because the water quality within this segment is better than applicable water quality standards, and will continue to be better after the application of best practicable control technology for industry and secondary treatment for municipalities. During this study, no known instances of pollution attributable to urban runoff were revealed. There are no significant irrigation return flows to this segment. Although there is a potential source of pollution to this segment from highly saline inflows from the upstream segment, construction of a low-flow diversion structure to divert the highly saline low flows to an off-channel reservoir has proven effective. As in other effluent limitation segments, the water is deemed suitable for all its designated uses.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1411, it is recommended that the existing segment classification of effluent limitation be maintained. It is also recommended that no changes to the Proposed Water Quality Standards be made.

Segment Plan for Segment 1412

Description.

Colorado River - FM 2059 near Silver to Lake J. B. Thomas (Colorado River Dam)

Classification.

Type - Water Quality

Reason - Violation of dissolved oxygen stream standards.

1. Note: Additional information regarding segment classification is included in Section VI.

2. Recommendation: Recommend that tributary Beals Creek be given separate segment status.

Ranking.

Basin - 5

State - 71

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.

Municipal wastewater treatment plants	- 16 (7 discharge)
Municipal water treatment plants	- 1
Livestock operations	- 4 (no discharge)
Sand and gravel operations	- 1 (no discharge)
Thermoelectric power generation operations	- 2 (2 discharge)
Heavy industrial operations	- 4 (no discharge)
Commercial-Industrial solid waste disposal facilities	- 3

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc., is included in Section V and/or the accompanying proposed segment effluent limitation and compliance schedule for NPDES (Table VIII-13)

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Non-Point Sources.

Urban Runoff.

Of the seven communities which lie within the contributing area tributary to this segment and have a population (1970) greater than 200, five have a defined stormwater sewer system. The largest of the communities, Big Spring, has a population (1970) of 48,264. (See Section V.) To date, there have been no known instances of pollution attributable to urban runoff from these areas.

Natural Sources.

As described in Section V, some evidence exists that this segment may be subject to contamination by leaching of natural mineral deposits. As noted, this source is difficult to isolate from the contamination caused by oil field brines. Further comprehensive study is necessary, directed expressly at location and possible isolation of these deposits.

Oil Field Brines.

Evidence exists that substantial contamination of segment waters may be attributable to oil field brines. During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of this survey are included in Appendix D of Volume 2.

Segment 1412 has a serious salt water pollution problem, as indicated by the high chloride concentration at Ira, Texas. The three main areas are Randalls Corner, Knapp, and Bluff Creek. The Randalls Corner area is located just west of Snyder on Highway 180.

No conditions were found which might contribute to surface water pollution except residual salt. The most likely source of ground and surface water contamination appeared to be residual salt deposited in open pits and stream beds prior to 1969 when open pit disposal of gas and oil well brines was discontinued. The work done in this area is important in the evaluation of alternatives to the salt problem, in that it points out the residual problems.

The Knapp area is located a few miles south and slightly west of Randalls Corner. The area is under investigation by the Railroad Commission to eliminate the possibility of any current pollution. The problem is that of high salt concentration in seeps. This type of problem is normally associated with residual salt deposited in open pits and stream beds.

The Bluff Creek area problem is located on the Colorado River below Lake J. B. Thomas. Samples taken from the Colorado River show a marked increase in chlorides in this area. The maximum chloride concentration in 1950 was 930 ppm; in 1964, concentrations reached over 1600 ppm in random samples, according to TWDB report #71. In April 1968, the Railroad Commission plugged two abandoned wells in this area. Four other wells were located which could be contributing to the increased chloride count in the river. These wells have not been plugged and no specific date to re-enter and plug these four wells has been set by the Railroad Commission. Before the wells are plugged, the Railroad Commission must collect data, forward files for action and hold public hearings.

Irrigation Return Flow.

There are no irrigation return flows to this segment.

Municipal Solid Waste Disposal Facilities.

All known municipal solid waste disposal sites within the Basin are shown on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Residual Waste Disposal:

Due to the arid nature of the climate for the segment, air-drying of residual sludges with ultimate disposal as fertilizer or in a landfill is the most efficient and practical method of disposal. No contamination of segment waters has been associated with residual wastes.

Total Maximum Daily Loads.

In accordance with TWQB policy with regard to waste load allocation methodology, the segment was examined in Section VI. It was determined that the stream-flow condition for the analysis was zero, such that no allocation could be justified. This low-flow condition would indicate that in reaches below municipal treatment facilities, the segment is effluent dominated.

Segment Strategy.

As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-13.

Monitoring Plan.

The segment will be monitored by chemical sampling station 1412.01 (formerly 1403.32) at FM 2059 near Silver and chemical-pesticide sampling station 1412.02 at State Highway 350 southwest of Ira.

Conclusions.

Segment 1412 was initially classified as water quality limited because the instream water was found to be in violation of the proposed stream standards, specifically the DO stream standards. The violation, a DO of 1.0 mg/l, was monitored at TWQB Station 1403.32. The flow is intermittent; therefore, no allocations were made. All municipal dischargers are limited under the proposed NPDES permits to "no-discharge" conditions as dictated by the "most cost-effective" treatment process to meet requirements of PL 92-500.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1412, it is recommended that the existing segment classification of water quality be maintained. It is also recommended that no changes to the Proposed Water Quality Standard be made.

TABLE VIII - 13

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1412 **SEGMENT DESCRIPTION:** Colorado River-FM 2059 near Silver to Lake J. B. Thomas

SEGMENT CLASSIFICATION: Water Quality Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit: Permit Conditions						Compliance Schedule	Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
Andrews	10119-01	1.20 No Dis.	20	20		1.20 No Dis.						1-74					0
Big Spring	10089-01	2.80	20	20	a, b	3.50 No Dis.						1-74	1-76	C	1.5	11	1,558,000
Coahoma	10723-01	0.0868 No Dis.	35	–		.10 No Dis.						1-74	6-76	B	.5	21	10,700
Colorado City	10077-01	0.350 No Dis.	35	–		.35 No Dis.						1-74					0
Denver City (North)	10087-01	0.150 No Dis.	–	–		.122 No Dis.						1-74	1-76	B	1.0	17	54,200
Denver City (South)	10087-02	0.150 No Dis.	–	–		.275 No Dis.						1-74	1-76	B	1.0	18	61,500
Lamesa	10107-01	1.880	20	20		1.8 No Dis.	20	20			b	1-74					0
Loraine	10430-01	0.250	20	35		.25 No Dis.						1-74	6-76	G	1.0	55	61,000
Midland (Main)	10223-01	4.870	20	20		4.670 No Dis.	20	20			b	1-74					0
Midland (Airport)	10223-02	1.00 No Dis.	20	20		1.00 No Dis.						1-74					0
Odessa	10238-01	5.50	20	20		10.0 No Dis.						1-74	1-76	C	1.5	30	1,116,600
Plains	10114-01	0.09	20	–		.09 No Dis.						1-74	1-76	B	1.0	22	17,600
Seagraves	10275-01	0.28 No Dis.	20	20		.28 No Dis.						1-74	1-76	B	.5	19	275,900
Seminole	10287-01	0.52 No Dis.	35	–		.52 No Dis.						1-74					0
Stanton	11043-01	0.20 No Dis.	20			.20 No Dis.						1-74	1-76	B	1.0	20	34,100
Snyder	10056-01	2.0	20	–		2.0 No Dis.						1-74	6-76	G	1.0	52	330,000

TABLE VIII - 13 (Cont'd.)

Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule: Permit	Compliance Schedule: Complete Construction
WATER TREATMENT PLANTS						
Snyder	10056-02		n	o	Dec 74	Jan 77
LIVESTOCK OPERATIONS						
Baca Cattle Feeders	01537	Cattle Feedlot	e, j	r, s	Dec 74	Jan 77
Ezell-Key Grain Co., Inc.	01679	Cattle Feedlot	e, j	r, s	Dec 74	Jan 77
W. L. Schroeder Meat Co.	20434	Slaughterhouse-Meatpacking	e, g	r, s	Dec 74	Jan 77
Texas Calf Palace, Inc.	01438	Cattle Preconditioning	e, j	r, s	Dec 74	Jan 77
SAND & GRAVEL WASHING OPERATIONS						
Colorado Sand & Gravel Co.	00488	Sand & Gravel Washing	k	q, r	Dec 74	Jan 77
THERMOELECTRIC POWER GENERATION OPERATIONS						
Texas Electric Service Co.						
(Morgan Creek No. 1)	00554-01	Power Plant	l	r, t	Dec 74	Jan 77
(Morgan Creek No. 2)	00554-02	Power Plant	l	r, t	Dec 74	Jan 77
HEAVY INDUSTRIAL OPERATIONS						
El Paso Products, Inc.	01304	Petrochemical Plant	m	r, u	Dec 74	Jan 77
General Tire & Rubber Co.	00817	Mfg-BD, Styrene, Syn. Rubber	m	r, u	Dec 74	Jan 77
Shell Oil Company	01437	Petroleum Refinery (Odessa)	m	r, u	Dec 74	Jan 77
Vulcan Materials Co. (Chemical Div.)	00503	Mfg-Chlorine and Caustic	m	r, u	Dec 74	Jan 77
COMMERCIAL-INDUSTRIAL SOLID WASTE DISPOSAL FACILITIES						
El Paso Products Company	20260	Landfill from Solid Wastes of Petrochemical Plant	i	y		
Rexene Polymers Company	20464	Chlorine and Caustic	i	y		
Vulcan Materials Company	20327	Mfg-Chlorine and Caustic	i	y		

Segment Plan for Segment 1413

Description.

Lake J. B. Thomas

Classification.

Type - Water Quality

Reason - Violation of pH stream standards

Note: Additional information regarding segment classification is included in Section VI.

Ranking.

Basin - 2

State - 46

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.

Municipal wastewater treatment plants - 3 (no discharge)

Sand and gravel-washing operations - 1 (no discharge)

It should be noted that all of the municipal facilities are located in a portion of the reservoir's drainage area which is generally recognized as hydraulically noncontributing.

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc., is included in Section V and/or the accompanying proposed segment effluent limitation and compliance schedule for NPDES (Table VIII-14).

Non-Point Sources.

Urban Runoff.

There are several population concentrations in the "drainage" area of this segment. However, as noted in the previous section, the towns are situated in the noncontributing area.

Natural Source.

There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.

During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and gound water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Agricultural Runoff and Irrigation Return Flow.

As noted throughout this report, there is extensive irrigated farming in the area. However, in view of the water situation, return flow or runoff is virtually non-existent. Consequently, these flows do not pose a pollution threat to the lake.

Municipal Solid Waste Disposal Facilities.

All known municipal solid waste disposal sites within the Basin are shown on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Individual Sewage Disposal Facilities.

There is virtually no development around the lake, and this condition is not expected to change during the study period. Consequently, septic tanks do not appear to present a serious pollution threat to the lake. Regardless, continuing efforts should be taken to insure the continued use of this reservoir as a municipal water supply.

Residual Waste Disposal.

Due to the arid climate of the area, air-drying of sludges on sludge drying beds is highly desirable. The residue from the beds is removed to a landfill or used as fertilizer. Waste disposal does not pose any significant problem in this area.

Total Maximum Daily Loads.

This segment's classification was based on a pH field analysis which yielded a value of 8.9, as opposed to the standard of 8.5. As noted in Section VI, this reading was not characteristic of other pH values monitored in the lake. Further, the field analysis was not verified by laboratory analysis. Therefore, in view of these facts, and those

noted in Section VI, it is hereby recommended that the segment be reclassified to Effluent Limited.

Segment Strategy.

As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-14.

Monitoring Plan.

The TWQB will continue to monitor this segment at station 1413.01 (formerly 1405.27) which is located at the Big Spring pump station upstream from the dam and north of Vincent.

Conclusions.

Segment 1413 was initially classified as water quality limited because the instream water was found to be in violation of the proposed stream standards, specifically the pH stream standard. The violation, a pH of 8.9 at TWQB Station 1405.27, was not verified by laboratory analysis. There are no dischargers to this segment.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1413, it is recommended that the existing segment classification be changed to effluent limitation. It is also recommended that no changes to the Proposed Water Quality Standard be made.

TABLE VIII - 14

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1413

SEGMENT DESCRIPTION: Lake J. B. Thomas

SEGMENT CLASSIFICATION: Water Quality Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit: Permit Conditions						Compliance Schedule	Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD lbs/day	SS lbs/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
Brownfield	10577-01	0.70 No Dis.	20	112		1.0 No Dis.						1-74	6-76	A	1.0	61	627,500
Meadow	10346-01	0.05 No Dis.	–	–		.05 No Dis.						1-74	1-76	B	.5	24	5,100
Sundown	11253-01	No Dis.	–	–		.14 No Dis.						1-74	1-76	B	1.0	23	12,930
Whiteface						.075 No Dis.						1-74	1-77	G	.5	92	24,220

Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule: Permit	Compliance Schedule: Complete Construction
SAND & GRAVEL WASHING OPERATIONS						
R. E. Janes Gravel Co., Inc.	20320	Sand and Gravel Washing	h, k	p, r		

Segment Plan for Segment 1414

Description.
Pedernales River

Classification.
Effluent Limitation

Note: Additional information regarding segment classification is included in Section VI.

Ranking.
Basin - 20
State - 249

Point Sources.

Municipal wastewater treatment plants	- 2 (2 discharge)
Municipal water treatment plants	- 1
Livestock operations	- 3 (no discharge)
Sand and gravel operations	- 2 (no discharge)

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc., is included in Section V and/or the accompanying proposed segment effluent limitation and compliance schedule for NPDES (Table VIII-15).

Non-Point Sources.

Urban Runoff.
Of the three communities which lie within the area tributary to this segment and have a population (1970) greater than 200, only one has a defined stormwater sewer system. The largest of the communities, Fredericksburg, has a population (1970) of 5,326. To date, there have been no known instances of population attributable to urban runoff from these areas.

Natural Sources.
There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.

During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Irrigation Return Flow.

As can be seen on Plate V-7, in Section V, irrigation return flows may be expected from numerous irrigation sites adjacent to the segment. No evidence is known to indicate that this return flow would have a detrimental effect on the water quality of the segment.

Municipal Solid Waste Dispoal Facilities.

All known municipal solid waste disposal sites within the Basin are shown on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Residual Waste Disposal.

Due to the arid nature of the climate for the segment, air-drying of residual sludges with ultimate disposal as fertilizer or in a landfill is the most efficient and practical method of disposal. No contamination of segment waters has been associated with residual wastes.

Total Maximum Daily Loads.

Total maximum daily loads are not applicable to effluent limitation segments since, by definition, conformance to the national goals of best practicable waste treatment technology for industry and secondary treatment of domestic wastewater by municipalities will not result in a violation of the stream standards for this segment.

Segment Strategy.

As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-15.

Monitoring Plan.

The segment will be monitored by chemical-pesticide-biological sampling station 1414.01 (formerly 1407.15) at U.S. 281 northeast of Johnson City and chemical-biological station 1414.02 at U.S. 290 southeast of Fredericksburg.

Conclusions.

Segment 1414 was classified effluent limitation because the water quality within this segment is better than applicable water quality standards and will continue to be better after the application of best practicable control technology for industry and secondary treatment for municipalities. During this study, no known instances of pollution attributable to urban runoff, natural sources, or oil field brines were revealed. Although irrigation return flows may be expected from irrigation sites adjacent or tributary to this segment, no evidence is known to indicate that this return flow would have a detrimental effect on the water quality of this segment. As in other effluent limitation segments, the water is deemed suitable for all its designated uses.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1414, it is recommended that the existing segment classification of effluent limitation be maintained. It is also recommended that no changes to the Proposed Water Quality Standards be made.

TABLE VIII - 16

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1414

SEGMENT DESCRIPTION: Pedernales River

SEGMENT CLASSIFICATION: Effluent Limitation Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit: Permit Conditions						Proposed NPDES Permit: Compliance Schedule	Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
Fredericksburg	10171-01	1.00	20	20		1.0 No Dis.						1-74					0
Johnson City	10198-01	0.004	20	88		.1 No Dis.						1-74	1-76	8	1.0		42,300

					Compliance Schedule	
Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Permit	Complete Construction
WATER TREATMENT PLANT						
Johnson City	10198-02		n	o	Dec 74	Jan 77
LIVESTOCK OPERATIONS						
Market Produce, Inc.	01613	Turkey Feedlot	e, j	r, s	Dec 74	Jan 77
Herbert E. Mertz, Jr.	01591	Turkey Feedlot	e, j	r, s	Dec 74	Jan 77
C. A. Staats Turkey Farm	01656	Turkey Feedlot	e, j	r, s	Dec 74	Jan 77
SAND & GRAVEL WASHING OPERATIONS						
Weirich Bros., Inc.	00480-03	Sand & Gravel Washing (S&GW)	k	q, r	Dec 74	Jan 77
Weirich Bros., Inc.	00480-04	S&GW	k	p, r		

Segment Plans for Segment 1415

Description.

Llano River

Classification.

Effluent Limitation

Note: Additional information regarding segment classification is included in Section VI.

Ranking.

Basin - 18
State - 226

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.

Municipal wastewater treatment plants	- 3 (no discharge)
Municipal water treatment plants	- 1
Livestock operations	-13 (no discharge)
Sand and gravel washing operations	- 7 (no discharge)
Heavy Industrial operations	- 2 (1 discharge)

Note; Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc., is included in Section V and/or the accompanying proposed segment effluent limitation and compliance schedule for NPDES (Table VIII-16).

Non-Point Sources.

Urban Runoff.

Of the four communities which lie within the area tributary to this segment and have a population (1970) greater than 200, none have a defined stormwater sewer system. The largest of the communities, Junction, has a population (1970) of 2660. To date, there have been no known instances of pollution attributable to urban runoff from these areas.

Natural Sources.

There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.

During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Irrigation Return Flow.

There are no irrigation return flows to this segment.

Municipal Solid Waste Disposal Facilities.

All known municipal solid waste disposal sites within the Basin are shown on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Residual Waste Disposal.

Due to the arid nature of the climate for the segment, air-drying of residual sludges with ultimate disposal as fertilizer or in a landfill is the most efficient and practical method of disposal. No contamination of segment waters has been associated with residual wastes.

Total Maximum Daily Loads.

Total maximum daily loads are not applicable to effluent limitation segments since, by definition, conformance to the national goals of best practicable waste treatment technology for industry and secondary treatment of domestic wastewater by municipalities will not result in a violation of the stream standards for this segment.

Segment Strategy.

As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-16.

Monitoring Plans.

The segment will be monitored by two chemical-biological sampling stations. Station 1415.01 is located at a county road 6.5 miles upstream from Kingsland. Station 1415.02 (formerly 1408.16) is located 0.4 miles downstream from State Highway 16 at Llano.

Conclusions.

Segment 1415 was classified effluent limitation because the water quality within this segment is better than applicable water quality standards, and will continue to be better after the application of best practicable control technology for industry and secondary treatment for municipalities. During this study, no known instances of pollution attributable to urban runoff, nature sources, or oil field brines were revealed. Also, there are no irrigation return flows to this segment. As in other effluent limitation segments, the water is deemed suitable for all its designated uses.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1415, it is recommended that the existing segment classification of effluent limitation be maintained. It is also recommended that no changes to the Proposed Water Quality Standards be made.

TABLE VIII-16

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1415

SEGMENT DESCRIPTION: Llano River

SEGMENT CLASSIFICATION: Effluent Limitation Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit											
						Permit Conditions						Compliance Schedule					
													Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
Junction	10189-01	0.21	22	20		0.21 No Dis.						1-74					0
Llano	10209-03	0.15	20	20		0.26 No Dis.						1-74					0
Mason	10670-01	0.135	20	54		0.141 No Dis.						1-74					0

TABLE VIII - 16 (Cont'd.)

Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule Permit	Compliance Schedule Complete Construction
WATER TREATMENT PLANT						
Llano	10209-04		n	o	Dec 74	Jan 77
LIVESTOCK OPERATIONS						
Bar D Hog Company	01467	Swine Feedlot	e, j	r, s	Dec 74	Jan 77
F&M Feedlot	20077	Commercial Swine Production (CSP)	e, f	r, s	Dec 74	Jan 77
Clarence Hasse	20313	CSP	e, f	r, s	Dec 74	Jan 77
A. J. & A. D. Hopson	20294	CSP	e, f	r, s	Dec 74	Jan 77
Sterling Jordan Feedlot	20469	CSP	e, f	r, s	Dec 74	Jan 77
Mason Feed Store	01449	Swine and Cattle Feedlot	e, j	r, s	Dec 74	Jan 77
Mason Feeders, Inc.	01454	Cattle Feedlot	e, j	r, s	Dec 74	Jan 77
Charles H. Pluenneke	20026	CSP	e, f	r, s	Dec 74	Jan 77
Pontotoc Swine Breeders, Inc.	01472	Swine Farrowing Operation	e, j	r, s	Dec 74	Jan 77
Sam Rabb	20290	CSP	e, f	r, s	Dec 74	Jan 77
Simpson & Simpson Hog Co.	20297	CSP	e, f	r, s	Dec 74	Jan 77
Elmer R. Smith	20291	CSP	e, f	r, s	Dec 74	Jan 77
M. J. Wootan Custom Feeding Lot	20104	CSP	e, f	r, s	Dec 74	Jan 77
SAND & GRAVEL WASHING OPERATIONS						
Weirich Bros. Inc.	00460-05	Sand & Gravel Washing (S&GW)	k	q, r	Dec 74	Jan 77
Weirich Bros. Inc.	00460-06	S&GW	k	q, r	Dec 74	Jan 77
Weirich Bros. Inc.	00460-07	S&GW	k	q, r	Dec 74	Jan 77
Weirich Bros. Inc.	00460-08	S&GW	k	q, r	Dec 74	Jan 77
Weirich Bros. Inc.	00460-09	S&GW	k	q, r	Dec 74	Jan 77
Weirich Bros. Inc.	01341	S&GW	k	p, r		
Weirich Bros. Inc.	01345	S&GW	k	p. r		
HEAVY INDUSTRIAL OPERATIONS						
Cedar Fiber Co., Inc.	01412	Cedar Oil Mill	m	r, u	Dec 74	Jan 77
The Paks Corporation	01391	Cedar Oil Mill	m	r, v	Dec 74	Jan 77

Segment Plan for Segment 1416

Description.
San Saba River

Classification.
Effluent Limitation

Note: Additional information regarding segment classification is included in Section VI.

Ranking.
Basin - 17
State - 213

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.
Municipal Wastewater Treatment Plants - 6 (1 discharge)
Livestock Operation - 1 (No discharge)
Sand and Gravel Washing Operation - 1 (No discharge)
Heavy Industrial Operations - 1 (No discharge)

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is included in Section V and/or the accompanying Proposed Segment Effluent Limitation and Compliance Schedule for NPDES (Table VIII-17)

Non-Point Sources.

Urban Runoff.
Of the five communities which lie within the area tributary to this segment and have a population (1970) greater than 200, only Brady has a defined stormwater sewer system. Brady is the largest of these communities with a population (1970) of 5,557. To date, there have been no known instances of pollution attributable to urban run-off from these areas.

Natural Sources.
There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.
During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Agricultural Runoff & Irrigation Return Flow.
As noted in Section III, there are extensive irrigation diversions both in the headwaters and in the lower reach of the river. There is very little if any return flow to the upper reach; however, as illustrated in Plate V-7, sizeable return flows can be expected in the lower reach of the river. Dependent on the quantity and quality of these return flows, they could have a pronounced effect on both the San Saba River and the Colorado River. However, there have been no known return flows to date.

Municipal Solid Waste Disposal Facilities.
All known municipal solid waste disposal sites within the Basin are located on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Residual Waste Disposal.
Air drying of sludges on sludge drying beds has proven acceptable in this area. The residue from the beds is removed to a landfill or used as fertilizer. Residual waste disposal does not pose any significant problem in this area.

Total Maximum Daily Loads.
Total maximum daily loads are not applicable to effluent limitation segments since, by definition, conformance to the national goals of best practicable waste treatment technology for industry and secondary treatment of domestic wastewater by municipalities will not result in a violation of the stream standards for this segment.

Segment Strategy.

As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-17.

Monitoring Plan.

The TWQB currently operates one quality monitoring station (1409. 18) on the State Hwy. 16 bridge north of San Saba. In addition to the chemical-biological station 1416.01 (formerly 1409.18), station 1416.02 at FM 9092, 5 miles downstream from Menard will be used to monitor the segment. Obviously, by virtue of its classification, the water quality is such that it can meet its prescribed uses. In summary, it should be noted that the practicality of a pesticide station in the lower reach of the river should be evaluated. This is particularly worth investigation, considering the sizeable amount of potential return flows in the reach.

Conclusions.

Segment 1416 was classified effluent limitation because the water quality within this segment is better than applicable water quality standards and will continue to be better after the application of best practicable control technology for industry and secondary treatment for municipalities. During this study, no known instances of pollution attributable to urban runoff, natural sources, or oil field brines were revealed. Although sizeable return flows can be expected in the lower portions of this segment, there have been no known instances of pollution of this segment. As in other effluent limitation segments, the water is deemed suitable for all its designated uses.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1416, it is recommended that the existing segment classification of effluent limitation be maintained. It is also recommended that no changes to the Proposed Water Quality Standards be made.

TABLE VIII - 17

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1416

SEGMENT DESCRIPTION: San Saba River

SEGMENT CLASSIFICATION: Effluent Limitation Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit: Permit Conditions						Proposed NPDES Permit: Compliance Schedule	Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
Brady (Curtis Field)	10132-02	0.014 No Dis.	20	20		0.014 No Dis.						1-74					0
Brady (Main Plant)	10132-01	1.00	20	20		1.00 No Dis.						1-74					0
Eden	10681-01	0.187	30	101		0.19 No Dis						1-74					0
Menard	10346-01	0.18	20	–		0.18 No Dis.						1-74					0
Richland Springs	10686-01	0.05	20	20		0.05 No Dis.						1-74	6-76	D	1.0	88	22,500
San Saba	10687-01	0.126 No Dis.	20	20		0.126 No Dis.						1-74					0

Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule: Permit	Compliance Schedule: Complete Construction
LIVESTOCK OPERATION						
Kothmann Commission Co.	01661	Sheep Feedlot	e, j	r, s	Dec 74	Jan 77
SAND & GRAVEL WASHING OPERATION						
Pennsylvania Glass Sand Corporation	01683	Sand and Gravel Washing	k	p, r		
HEAVY INDUSTRIAL OPERATION						
Roddie Wool Scouring	01287	Wool Scouring	m	r, u	Dec 74	Jan 77
WATER TREATMENT PLANT						
San Saba	10687-03		n	o	Dec 74	Jan 77

Segment Plan for Segment 1417

Description.

Pecan Bayou - Colorado River Confluence to Lake Brownwood Dam

Classification.

Type - Water Quality

Reason - Violation of dissolved oxygen stream standards

Note: Additional information regarding segment classification is included in Section VI.

Ranking.

Basin - 1

State - 15

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.

Municipal Wastewater Treatment Plants - 2 (2 discharge)

Municipal Water Treatment Plants - 2

Livestock Operations - 6 (no discharge)

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc., is included in Section V and/or the accompanying Proposed Segment Effluent Limitation and Compliance Schedule for NPDES (Table VIII-18).

Non-Point Sources.

Urban Runoff.

Of the four communities which lie within the area tributary to this segment and have a population (1970) greater than 200, one has a defined stormwater sewer system. The largest of the communities, Brownwood, has a population (1970) of 17,368. To date, there have been no known instances of pollution attributable to urban runoff from these areas.

Natural Sources.
There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.
Evidence exists that some contamination of segment waters may be attributable to oil field brines. During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of this survey are included in Appendix D of Volume 2. The survey revealed one well with a salt water flow of 2,940 gals/day with 6,000 mg/l chlorides. The well has been submitted for plugging.

Irrigation Return Flow.
As can be seen on Plate V-7 in Section V, irrigation return flows may be expected from several irrigation sites adjacent to the segment.

Municipal Solid Waste Disposal Facilities.
All known municipal solid waste disposal sites within the Basin are located on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Residual Waste Disposal.
Due to the arid nature of the climate for the segment, air-drying of residual sludges, with ultimate disposal as fertilizer in a landfill is the most efficient and practical method of disposal. No contamination of segment waters has been associated with residual wastes.

Total Maximum Daily Loads.
Waste load allocations have been performed for this segment in Section VI of this report. As noted therein, the segment is heavily effluent dominated. Under those conditions, the analysis revealed that no allocation was required. Since the segment is heavily effluent dominated, it would not be practical to redesignate the segment at this time.

Segment Strategy.
As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-18.

Monitoring Plans.

The segment will be monitored by chemical-biological sampling station 1417.01 (formerly 1400.42) at FM 2126 southeast of Brownwood and by chemical station 1417.02 (formerly 1400.20) at US 377 in Brownwood.

Conclusions.

Segment 1417 was initially classified as water quality limited because the in-stream water was found to be in violation of the proposed stream standards, specifically the DO stream standards. The violations, a DO of 4.5, 3.0 and 4.0, were monitored at TWQB Stations 1400.20 and 1400.42. For this segment, a wasteload allocation confirms that no stream assimilative capacity is available for discharge of carbonaceous oxygen-demanding materials. All dischargers, with the exception of one, are limited under the proposed NPDES permits to "no-discharge" conditions as dictated by the "most cost-effective" treatment process to meet requirements of PL 92-500. The one discharger has a very small flow and will be required to treat to at least the "best practicable" levels.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1417, it is recommended that the existing segment classification of water quality be maintained. It is also recommended that no changes to the Proposed Water Quality Standard be made.

TABLE VIII - 16

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1417 SEGMENT DESCRIPTION: Pecan Bayou-Colorado River confluence to Lake Brownwood

SEGMENT CLASSIFICATION: Water Quality Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit: Permit Conditions						Compliance Schedule	Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
Brownwood	10565-01	4.00	20	20		3.0 No Dis.						10-73	10-75	B, G	1.5	5	1,400,000
Brownwood	10565-02	0.005	20	20		.01 No Dis.						1-74					0

Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule: Permit	Compliance Schedule: Complete Construction
WATER TREATMENT PLANTS						
Brown Co. WCID No. 1	10391		n	o	Dec 74	Jan 77
Early	10782		n	o	Dec 74	Jan 77
LIVESTOCK OPERATIONS						
Alpha Pork Producers	20163	Commercial Swine Production	e, f	r, s	Dec 74	Jan 77
Bean-Driskill Swine Producers	01457	Swine Feedlot	e, j	r, s	Dec 74	Jan 77
Don Gosslin Farms	01650	Sheep Feedlot	e, j	r, s	Dec 74	Jan 77
Elam Mills	01625	Sheep Feedlot	e, j	r, s	Dec 74	Jan 77
B. H. Yeager Feedlot	01672	Cattle Feedlot	e, j	r, s	Dec 74	Jan 77
HEAVY INDUSTRIAL OPERATIONS						
Atchison, Topeka & Santa Fe Railroad Company	00729	Railroad Shop Area, Locomotive Fueling Facility, and Switching Area	m	m, r	Dec 74	Jan 77

Segment Plan for Segment 1418

Description.

Lake Brownwood

Classification.

Type - Water Quality

Reason - So classified due to lack of sufficient data.

Note: Additional information regarding segment classification is included in Section VI.

Ranking.

Basin - 14

State - 145

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.

Municipal Wastewater Treatment Plants - 2 (1 discharge)

Municipal Water Treatment Plants - 3

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is included in Section V and/or the accompanying Proposed Segment Effluent Limitation and Compliance Schedule for NPDES (Table VIII-19).

Non-Point Sources.

Urban Runoff.

There are no cities within the immediate drainage area of the reservoir whose storm-water drains to the lake. All three of the primary population concentrations located within the drainage area of the reservoir have defined stormwater sewer systems and discharge to streams tributary to the lake. The largest of these three is Coleman-1970 population of 5,608. To date, there have been no known instances of degradation of the lake attributable to urban runoff.

Natural Sources.

There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil-Field Brines.

During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Agricultural Runoff & Irrigation Return Flow.

There is moderate farming activity in this segment, most of which utilizes irrigation. For all practical purposes, there is very little, if any, return flow to the stream. Understandably, there have been no recorded instances of pollution in the segment.

Municipal Solid Waste Disposal Facilities.

All known municipal solid waste disposal sites within the Basin are shown on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Individual Sewage Disposal Facilities.

There has been moderate develoment around the lake. No substantial further growth is expected in development adjacent to the lake. Efforts are currently underway to avoid contamination of the lake by septic tanks. Continuing efforts should be made to prevent the contamination of the lake.

Residual Waste Disposal.

Air-drying of sludges on sludge drying beds has proven acceptable in this area. The residue from the beds is removed to a landfill or used as fertilizer. Residual waste disposal does not pose any significant problem in this area.

Total Maximum Daily Loads.

In accordance with Texas Water Quality Board policy, all segments which had insufficient data to positively define the segment as effluent limitation were classified as water quality limiting until such time as adequate data were available to verify the designation.

Designation of this segment as water quality limiting does not indicate that any violation of stream standards has occurred or will occur. Therefore, waste load allocations are not justified for this segment at this time.

Segment Strategy.

As required in 40 CFR 131, the municipal facility requirements, schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-19.

Monitoring Plan.

Currently, there are no TWQB water quality monitoring stations on the lake. The water of the lake is suitable for contact and non-contact recreation, propagation of fish and wildlife, and domestic, industrial, and agricultural raw water supply. Under the proposed monitoring system, the lake will be monitored by two chemical stations, one (1418.01) located at the dam, and the other (1418.02) at State Hwy. 279 north of Brownwood.

Conclusions.

Segment 1418 was initially classified as water quality limited due to insufficient data to verify either compliance with or violation of the proposed stream standards. During this study, no known instances of pollution attributable to urban runoff, natural sources, or oil field brines were revealed. Also, there are no significant irrigation return flows to this segment. The waters of this segment are being used for domestic raw water supplies and contact and non-contact recreation and is also supporting the propagation of fish and wildlife. There are no known instances of contamination or pollution in this segment that would prevent the continued use of these waters for the above-stated purposes. Information furnished by the Texas State Department of Health reveals that water from this segment is used as a domestic raw water supply for the cities of Brownwood, Santa Anna, Early, Bangs, Zephyr and Brownwood State Park. Therefore, although no formal data are currently available, the TSDH approval of this segment for use as a domestic raw water supply indicates the acceptable quality of the waters. It is believed that the proposed TWQB monitoring program will further substantiate the acceptable quality of the water in this segment. All dischargers are limited under the proposed NPDES permits to "no-discharge" conditions as dictated by the "most cost effective" treatment process to meet requirements of PL 92-500.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1418, it is recommended that the existing segment classification be changed to effluent limitation. It is also recommended that no changes to the Proposed Water Quality Standard be made.

TABLE VIII - 19

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1418

SEGMENT DESCRIPTION: Lake Brownwood

SEGMENT CLASSIFICATION: Water Quality Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit: Permit Conditions						Compliance Schedule	Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
Coleman	10190-01	0.539	20	20		.539 No Dis.						1-74					0
Texas Parks and Wildlife	11189-01	0.01 No Dis.	20	20		.01 No Dis.	20	20			b	1-74		H	.5	84	5,000
Texas Parks and Wildlife	11365-01	0.025 No Dis.				.025 No Dis.	20	20				1-74	*				

* Under construction.

Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule: Permit	Compliance Schedule: Complete Construction
WATER TREATMENT PLANTS						
Coleman (Hords Creek)	10190-03		n	o	Dec 74	Jan 77
Coleman (Lake Scarborough)	10190-04		n	o	Dec 74	Jan 77
Santa Anna	10274-02		n	o	Dec 74	Jan 77

Segment Plan for Segment 1419

Description.
Lake Coleman

Classification.
Type - Water Quality
Reason - So classified due to lack of sufficient data.

Note: Additional information regarding segment classification is included in Section VI.

Ranking.
Basin - 13
State - 144

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources. None

Non-Point Sources.

Urban Runoff.
Of the two communities which lie within the area tributary to this segment and have a population (1970) greater than 200, neither has a defined stormwater sewer system. The largest of the communities; Tuscola, has a population (1970) of 497. To date, there have been no known instances of pollution attributable to urban runoff from these areas.

Natural Sources.
There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.
During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Irrigation Return Flow.

There are no irrigation return flows to this segment.

Municipal Solid Waste Disposal Facilities.

All known municipal solid waste disposal sites within the Basin are located on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Total Maximum Daily Loads.

Not applicable. No waste sources tributary to segment.

Segment Strategy.

Not applicable. No waste sources tributary to segment.

Monitoring Plan.

The segment will be monitored by one chemical sampling station (1419.01) located near the dam.

Conclusions.

Segment 1419 was initially classified as water quality limited due to insufficient data to verify either compliance with or violation of the proposed stream standards. During this study, no known instances of pollution attributable to urban runoff, natural sources, or oil field brines were revealed. Also, there are no irrigation return flows to this segment. The waters of this segment are being used for domestic raw water supplies and contact and non-contact recreation and are also supporting the propagation of fish and wildlife. There are no known instances of contamination or pollution in this segment that would prevent the continued use of these waters for the above-stated purposes. Information furnished by the Texas State Department of Health reveals that water from this segment is used as a domestic raw water supply for the municipalities of Coleman and Lawn. Therefore, although no formal data are currently available, the TSDH approval of this segment for use as a domestic raw water supply indicates the acceptable quality of the waters. It is believed that the proposed TWQB monitoring program will further substantiate the acceptable quality of the water in this segment. There are no dischargers to this segment.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1419, it is recommended that the existing segment classification be changed to effluent limitation. It is also recommended that no changes to the Proposed Water Quality Standard be made.

Segment Plan for Segment 1420

Description.
Pecan Bayou - above Lake Brownwood

Classification.
Type - Water quality
Reason - So classified due to lack of sufficient data.

Note: Additional information regarding segment classification is included in Section VI.

Ranking.
Basin - 6
State - 78

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.
Municipal Wastewater Treatment Plant - 2 (2 discharges)

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is included in Section V and/or the accompanying Proposed Segment Effluent Limitation and Compliance Schedule for NPDES (Table VIII-20).

Non-Point Sources.

Urban Runoff.
Clyde and Cross Plains are the two population concentrations in the segment and they both have a defined stormwater sewer system. To date, there has been no known instances of pollution attributable to urban runoff from these towns.

Natural Sources.
There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.

During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Agricultural Runoff & Irrigation Return Flow.

There is scattered farming activity in this segment, most of which utilize irrigation. For all practical purposes, there is very little, if any, return flow to the stream. Understandably, there have been no recorded instances of pollution in the segment.

Municipal Solid Waste Disposal Facilities.

All known municipal solid waste disposal sites within the Basin are located on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Residual Waste Disposal.

Air-drying of sludges on sludge drying beds has proven acceptable in this area. The residue from the beds is removed to a landfill or used as fertilizer. Residual waste disposal does not pose any significant problem in this area.

Total Maximum Daily Loads.

In accordance with TWQB policy, all segments which had insufficient data to positively define the segment as effluent limitation were classified as water quality limiting until such time as adequate data were available to verify the designation. Designation of this segment as water quality limiting does not indicate that any violation of stream standards has occurred or will occur. Therefore, waste load allocations are not justified for this segment at this time.

Segment Strategy.

As required in 40 CFR 131, the municipal facility requirements, schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-20.

Monitoring Plan.

Currently, there are no water quality monitoring stations in the segment. Known water uses include contact and non-contact recreation and propagation of fish and wildlife. The segment will be monitored by a chemical biological station 1420.01 at State Hwy. 279 south of Cross Cut.

Conclusions.

Segment 1420 was initially classified as water quality limited due to insufficient data to verify either compliance with or violation of the proposed standards. During this study, no known instances of pollution attributable to urban runoff, natural sources or oil field brines were revealed. There are no significant irrigation return flows to this segment. The flow is intermittent; therefore, no allocations were made. The two dischargers are limited under the NPDES permits to "no-discharge" conditions as dictated by the "most cost effective" treatment process to meet requirements of PL 92-500.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1420, it is recommended that the existing segment classification of water quality be maintained. It is also recommended that no changes to the Proposed Water Quality Standard be made.

TABLE VIII - 20

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1420

SEGMENT DESCRIPTION: Pecan Bayou – above Lake Brownwood

SEGMENT CLASSIFICATION: Water Quality Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit: Permit Conditions						Proposed NPDES Permit: Compliance Schedule	Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
Clyde	10149-01	0.32	20	20		.32 No Dis.						1-74	6-76	G	1.0	85	80,000
Cross Plains	10634-01	0.125	20	20		.125 No Dis.						1-74	6-76	A, G	1.0	10	239,000

Segment Plan for Segment 1421

Description.

Concho River - Colorado River confluence to fork in San Angelo, including South Fork to Lake Nasworthy Dam and North Fork to San Angelo Reservoir Dam

Classification.

Effluent limitation

Note: Additional information regarding segment classification is included in Section VI.

Ranking.

Basin - 25
State - 274

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.

Municipal Wastewater Treatment Plants	- 2 (1 discharge)
Municipal Water Treatment Plants	- 2
Livestock Operations	- 6 (no discharge)
Sand and Gravel Washing Operations	- 1 (no discharge)
Thermoelectric Power Generation Operations	- 1 (1 discharge)

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc., is included in Section V and/or the accompanying proposed Segment Effluent Limitation and Compliance Schedule for NPDES (Table VIII-21).

Non-Point Sources.

Urban Runoff.

The two communities which lie within the area tributary to this segment, San Angelo (pop. 73,402) and Miles (pop. 631), have some defined stormwater system. No known instances of pollution have been attributable to urban runoff from Miles. San Angelo, as described in Section V (Wastewater Sources-Urban Runoff) has had some contamination of downstream waters associated with the storm flow. As stated in Section V, this problem may be attributable to surcharging of the sanitary collection system rather than to actual urban runoff.

Natural Sources.
There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.
Evidence exists that some contamination of segment waters may be attributable to oil field brines. During the course of this study the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of fresh-water supplies, both surface and ground water. The results of this survey are included in Appendix D of Volume 2.

Irrigation Return Flow.
There are no irrigation return flows to this segment.

Municipal Solid Waste Disposal Facilities.
All known municipal solid waste disposal sites within the Basin are located on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Residual Waste Disposal.
Due to the arid nature of the climate for the segment, air-drying of residual sludges, with ultimate disposal as fertilizer or in a land-fill, is the most efficient and practical method of disposal. No contamination of segment waters has been associated with residual wastes.

Total Maximum Daily Loads.
Total maximum daily loads are not applicable to effluent limitation segments since, by definition, conformance to the national goals of best practicable waste treatment technology for industry and secondary treatment of domestic wastewater by municipalities will not result in a violation of the stream standards for this segment.

Segment Strategy.
As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-21.

Monitoring Plan.

The segment will be monitored by three sampling stations. Station 1421.01 (formerly 1410.21) is a chemical-pesticide-biological station at U.S. 83 at Paint Rock. Station 1421.02 is a chemical-biological station at FM 1692 south of Miles. Station 1421.03 (formerly 1410.38) is a chemical-biological-pesticide station at FM 380 near Veribest.

Conclusions.

Segment 1421 was classified effluent limiation because the water quality within this segment is better than applicable water quality standards, and will continue to be better after the application of best practicable control technology for industry and secondary treatment for municipalities. During this study, no known instances of pollution attributable to natural sources were revealed. There are no irrigation return flows to this segment. Although some contamination of downstream waters associated with storm flow in the San Angelo area has occurred, this problem may be attributable to surcharging of the sanitary collection system rather than to actual urban runoff. Evidence exists that some contamination of segment waters may be attributable to oil field brines; however, there have been no violations of the proposed stream standards. As in other effluent limitation segments, the water is deemed suitable for all its designated uses.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1421, it is recommended that the existing segment classification of effluent limitation be maintained. It is also recommended that no changes to the Proposed Water Quality Standards be made.

TABLE VIII - 21

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1421

SEGMENT DESCRIPTION: Concho River-Colorado River confluence to fork in San Angelo including north and south forks.

SEGMENT CLASSIFICATION: Effluent Limitation Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit: Permit Conditions						Compliance Schedule	Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
Miles	10138-01	0.08	20	20		0.08 No Dis.						1-74	6-76	S	1.0	91	8,100
San Angelo (Irr. Farm)	10841-03	5.107 No Dis.	33	124		7.36 No Dis.						10-73	10-75	A	1.5	1	2,180,000

Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule: Permit	Complete Construction
WATER TREATMENT PLANTS						
Concho Co. WCID No. 1	10815		n	p		
San Angelo	10841-01		n	o	Dec 74	Jan 77
LIVESTOCK OPERATIONS						
Marvin Goetz	20134	Commercial Swine Production (CSP)	e, f	r, s	Dec 74	Jan 77
Gene Newman Veribert Cattle Feeders	01204	Cattle Feedlot	e, j	r, s	Dec 74	Jan 77
Larry F. Oxley	20427	CSP	e, f	r, s	Dec 74	Jan 77
San Angelo By-products, Inc.	01894	Rendering Plant	e, j	r, s	Dec 74	Jan 77
San Angelo Feed Yards, Inc.	01522	Cattle Feedlot	e, j	r, s	Dec 74	Jan 77
Don Waggoner	20252	Swine Feedlot	e, f	r, s	Dec 74	Jan 77
SAND & GRAVEL WASHING OPERATIONS						
Montgomery Sand & Gravel, Inc.	01010	Sand & Gravel Washing	k	p, r		
THERMOELECTRIC POWER GENERATION OPERATIONS						
West Texas Utilities Co. (Concho Power Station)	00865	Power Plant	l	r, t	Dec 74	Jan 77

Segment Plan for Segment 1422

Description.
Lake Nasworthy

Classification.
Effluent limitation

Note: Additional information regarding segment classification is included in Section VI.

Ranking.
Basin - 23
State - 272

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.
Municipal Wastewater Treatment Plants - 1 (no discharge)
Thermoelectric Power Generation Operations - 3 (3 discharges)

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is included in Section V and/or the accompanying Proposed Segment Effluent Limitation and Compliance Schedule for NPDES (Table VIII-22).

Non-Point Sources.

Urban Runoff.
Only one community lies within the area tributary to this segment with a population (1970) greater than 200. Mertzon (pop. 513) does not have a defined stormwater sewer system and, to date, there have been no known instances of pollution attributable to urban runoff.

Natural Sources.
There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.

During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Irrigation Return Flow.

There are no irrigation return flows to this segment.

Municipal Solid Waste Disposal Facilities.

All known municipal solid waste disposal sites within the Basin are located on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Individual Sewage Disposal Facilities.

A heavy concentration of homes served by septic tanks surrounds this segment. Some evidence exists that contamination of the lake may necessitate installation of a collection system to serve this development, eventually tying into the San Angelo system below the segment.

Residual Waste Disposal.

Due to the arid nature of the climate for the segment, air-drying of residual sludges with ultimate disposal as fertilizer or in a landfill is the most efficient and practical method of disposal. No contamination of segment waters has been associated with residual wastes.

Total Maximum Daily Loads.

Total maximum daily loads are not applicable to effluent limitation segments since, by definition, conformance to the national goals of best practicable waste treatment technology for industry and secondary treatment of domestic wastewater by municipalities will not result in a violation of the stream standards for this segment.

Segment Strategy.

As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-22.

Monitoring Plan.

The segment will be monitored by a chemical station 1422.01 (formerly 1411.39) the bridge near the intake structure at the dam south of San Angelo.

Conclusions.

Segment 1422 was classified effluent limitation because the water quality within this segment is better than applicable water quality standards, and will continue to be better after the application of best practicable control technology for industry and secondary treatment for municipalities. During this study, no known instances of pollution attributable to urban runoff, natural sources or oil field brines were revealed. Also, there are no irrigation return flows to this segment. As in other effluent limitation segments, the water is deemed suitable for all its designated uses.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1422, it is recommended that the existing segment classification of effluent limitation be maintained. It is also recommended that no changes to the Proposed Water Quality Standards be made.

TABLE VIII - 22

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1422 SEGMENT DESCRIPTION: Lake Nasworthy

SEGMENT CLASSIFICATION: Effluent Limitation Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit: Permit Conditions						Proposed NPDES Permit: Compliance Schedule	Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
San Angelo (Concho Airfield)	10841-02	1.00 No Dis.				1.00 No Dis.						1-74					0

					Compliance Schedule	
Name	WCO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Permit	Complete Construction
THERMOELECTRIC POWER GENERATION						
West Texas Utilities Co. (Outlet 1)	01152-01	Power Plant	I	r, t	Dec 74	Jan 77
(Outlet 2)	01152-02	Power Plant	I	r, t	Dec 74	Jan 77
(Outlet 3)	01152-03	Power Plant	I	r, t	Dec 74	Jan 77

Segment Plan for Segment 1423

Description.
Twin Buttes Reservoir

Classification.
Type - Water Quality
Reason - So classified due to lack of sufficient data.

Note: Additional information regarding segment classification is included in Section VI.

Ranking.
Basin - 16
State - 147

Point Sources. None

Non-Point Sources.

Urban Runoff.
Of the two communities which lie within the area tributary to this segment and have a population (1970) greater than 200, none have a defined stormwater sewer system. The largest of the communities, El Dorado, has a population (1970) of 1,446. To date, there have been no known instances of pollution attributable to urban runoff from these areas.

Natural Sources.
There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.
During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

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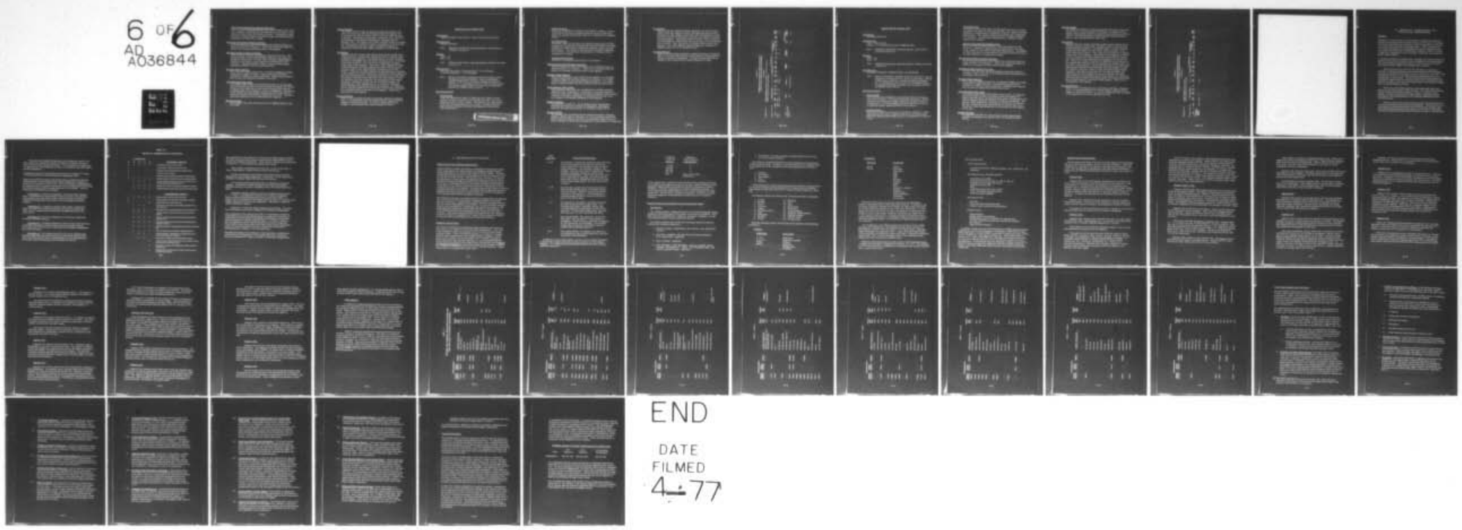

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Agricultural Runoff and Irrigation Return Flow.
There is moderate farming activity in the area tributary to the reservoir. However, conditions are such that there is very little, if any, runoff or return flow to the tributary streams. Consequently, there have been no known instances of pollution from this source, and this condition is not expected to change.

Municipal Solid Waste Disposal Facilities.
All known municipal solid waste disposal sites within the Basin are shown on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Individual Sewage Disposal Facilities.
There has been moderate development around the reservoir. Projections indicate increased development adjacent to the reservoir during the study period. To date, these individual sewage disposal systems are not known to have caused any contamination of the reservoir. Measures should be taken to deter any water quality degradation attendant with the projected growth.

Residual Waste Disposal.
Due to the arid climate of the area, air-drying of sludges on sludge drying beds is highly desirable. The residue from the beds is removed to a landfill or used as fertilizer. Residual waste disposal does not pose any significant problem in this area.

Total Maximum Daily Loads.
In accordance with Texas Water Quality Board policy, all segments which had insufficient data to positively define the segment as effluent limitation were classified as water quality limiting until such time as adequate data were available to verify the designation. Designation of this segment as water quality limiting does not indicate that any violation of stream standards has occurred or will occur. Therefore, waste load allocations are not justified for this segment.

Segment Strategy.
The strategy is the same as that noted in the "Segment Plan for Segment 1424."

Monitoring Plan.

The TWQB currently does not operate a monitoring station in the reservoir; however, under the proposed system the segment will be monitored by chemical station 1423.01 near the intake structure at the dam. The quality of the primary tributaries to the reservoir is monitored by the network outlined in the "Segment Plan for Segment 1424." According to the TWQB, the water quality is suitable for contact and non-contact recreation, propagation of fish and wildlife, and domestic raw water supply, although the segment is temporarily classified water quality limited due to lack of data.

Conclusions.

Segment 1423 was initially classified as water quality limited due to insufficient data to verify either compliance with or violation of the proposed stream standards. During this study, no known instances of pollution attributable to urban runoff, natural sources, or oil field brines were revealed. Also, there are no significant irrigation return flows to this segment. The waters of this segment are being used for domestic raw water supplies and contact and non-contact recreation and are also supporting the propagation of fish and wildlife. There are no known instances of contamination or pollution in this segment that would prevent the continued use of these waters for the above-stated purposes. Information furnished by the Texas State Department of Health reveals that water from this segment is used as a domestic raw water supply for the municipality of San Angelo. Therefore, although no formal data are currently available, the TSDH approval of this segment for use as a domestic raw water supply indicates the acceptable quality of the waters. It is believed that the proposed TWQB monitoring program will further substantiate the acceptable quality of the water in this segment. There are no dischargers to this segment.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1423, it is recommended that the existing segment classification be changed to effluent limitation. It is also recommended that no changes to the Proposed Water Quality Standard be made.

Segment Plan for Segment 1424

Description.
South and Middle Concho Rivers - above Twin Buttes Reservoir

Classification.
Effluent limitation

Note: Additional information regarding segment classification is included in Section VI.

Ranking.
Basin - 24
State - 273

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.
Municipal Wastewater Treatment Plants - 2 (1 discharge)
Livestock Operations - 1 (no discharge)

Note: Specific information regarding location of sources, type of wastewater treatment facilities, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is included in Section V and/or the accompanying proposed Segment Effluent Limitation and Compliance Schedule for NPDES (Tablve VIII-23).

Non-Point Sources.

Urban Runoff.
Of the two communities which lie within the area tributary to this segment and have a population (1970) greater than 200, none have a defined stormwater sewer system. The largest of the communities, El Dorado, has a population (1970) of 1,446. To date, there have been no known instances of pollution attributable to urban runoff from these areas.

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Natural Sources.

There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.

During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Irrigation Return Flow.

There are no irrigation return flows to this segment.

Municipal Solid Waste Disposal Facilities.

All known municipal solid waste disposal sites within the Basin are shown on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Residual Waste Disposal.

Due to the arid nature of the climate for the segment, air-drying of residual sludges with ultimate disposal as fertilizer or in a landfill is the most efficient and practical method of disposal. No contamination of segment waters has been associated with residual wastes.

Total Maximum Daily Loads.

Total maximum daily loads are not applicable to effluent limitation segments since, by definition, conformance to the national goals of best practicable waste treatment technology for industry and secondary treatment of domestic wastewater by municipalities will not result in a violation of the stream standards for this segment.

Segment Strategy.

As required in 40 CFR 131, the municipal facility requirements, municipal and industrial schedules of compliance, and effluent limits for all known point sources are detailed in Table VIII-23.

Monitoring Plan.

The segment will be monitored by two chemical-biological sampling stations. Station 1424.01 (formerly 1411.23) is located at Christoval. Station 1424.02 (formerly 1412.24) is on the Middle Concho River 0.5 miles southwest of Tullos Ranch Headquarters and northwest of Tankersley.

Conclusions.

Segment 1424 was classified effluent limitation, because the water quality within this segment is better than applicable water quality standards and will continue to be better after the application of best practicable control technology for industry and secondary treatment for municipalities. During this study, no known instances of pollution atrributable to urban runoff, natural sources, or oil field brines were revealed. Also, there are no irrigation return flows to this segment. As in other effluent limitation segments, the water is deemed suitable for all its designated uses.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1424, it is recommended that the existing segment classification of effluent limitation be maintained. It is also recommended that no changes to the Proposed Water Quality Standards be made.

TABLE VIII - 23

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1424 — SEGMENT DESCRIPTION: South and Middle Concho Rivers – above Twin Buttes Reservoir

SEGMENT CLASSIFICATION: Effluent Limitation Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit – Permit Conditions						Proposed NPDES Permit – Compliance Schedule	Construction				
Name	WQO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
Big Lake	10036-01	0.2538	20	152		.25 No Dis.	20	20			b	1-74					0
El Dorado	10165-01	0.072 No Dis.	20	80		.072 No Dis.						1-74	1-77				0

Name	WQO No.	Classification	Existing Permit Conditions	Proposed NPDES Conditions	Compliance Schedule – Permit	Compliance Schedule – Complete Construction
LIVESTOCK OPERATIONS						
Live Oak Farm	01453	Commercial Swine Production	e, j	r, s	Dec 74	Jan 77

Segment Plan for Segment 1425

Description.

San Angelo Reservoir

Classification.

Type - Water Quality

Reason - So classified due to lack of sufficient data.

Note: Additional information regarding segment classification is included in Section VI.

Ranking.

Basin - 15

State - 146

Note: Additional information regarding segment ranking is included in Section VI.

Point Sources.

Municipal Wastewater Treatment Plant - (no discharge)

Note: Specific information regarding location of the source, type of wastewater treatment facility, nature of wastewater, existing TWQB permit conditions, quantity and quality of effluent, etc. is included in Section V and/or the accompanying proposed segment Effluent Limitation and Compliance Schedule for NPDES (Table VIII-24).

Non-Point Sources.

Urban Runoff.

There are no major population concentrations within the drainage area of the reservoir. The area is extremely low density, and this situation is not expected to change notably during the study period. Consequently, it is understandable that urban runoff has not nor is it expected to pose a pollution threat to the reservoir.

Natural Sources.

There are no natural occurrences of salt domes, sulfates, or other materials that have been revealed during the course of this study within this segment which might result in a contamination of segment waters.

Oil Field Brines.

During the course of this study, the Railroad Commission of Texas surveyed all oil field activity within the Basin with regard to possible pollution or contamination of freshwater supplies, both surface and ground water. The results of that survey are included in Appendix D of Volume 2. No associated contamination or pollution in this segment was revealed.

Agricultural Runoff and Irrigation Flow.

There is moderate farming activity in the area tributary to the reservoir. However, conditions are such that there is very little, if any, runoff or return flow to the North Concho River. Consequently, there have been no known instances of pollution from this source, and this condition is not expected to change.

Municipal Solid Waste Disposal Facilities.

All known municipal solid waste disposal sites within the Basin are shown on Plate V-8 in Section V. There are no facilities which are known to be creating a pollution threat to this segment.

Individual Sewage Disposal Facilities.

To date, there has been sparse development around the reservoir. Therefore, septic tanks are not currently posing an immediate pollution threat to the reservoir.

Residual Waste Disposal.

Due to the arid climate of the area, air-drying of sludges and sludge drying beds is highly desirable. The residue from the beds is removed to a landfill or used as fertilizer. Residual waste disposal does not pose any significant problem in this area.

Total Maximum Daily Loads.

In accordance with Texas Water Quality Board policy, all segments which had insufficient data to positively define the segment as effluent limitation were classified as water quality limiting until such time as adequate data were available to verify the designation. Designation of this segment as water quality limiting does not indicate that any violation of stream standards has occurred or will occur. Therefore, waste load allocations are not justified for this segment at this time.

Segment Strategy.

As required in 40 CFR 131, the municipal facility requirements, schedule of compliance and effluent limits are detailed in Table VIII-24.

Monitoring Plan.

The TWQB currently has a monitoring station (1413.25) on the North Concho River 0.6 mile southeast of Carlsbad. In addition to this station, whose number under the proposed monitoring system will be 1400.07, the Board proposes to operate another chemical station, 1425.01, near the dam off the access road.

Conclusions.

Segment 1425 was initially classified as water quality limited due to insufficient data to verify either compliance with or violation of the proposed stream standards. During this study, no known instances of pollution attributable to urban runoff, natural sources, or oil field brines were revealed. Also, there are no significant irrigation return flows to this segment. The waters of this segment are being used for domestic raw water supplies and contact and non-contact recreation and are also supporting the propagation of fish and wildlife. There are no known instances of contamination or pollution in this segment that would prevent the continued use of these waters for the above-stated purposes. Information furnished by the Texas State Department of Health reveals that water from this segment is used as a domestic raw water supply for the municipality of San Angelo. Therefore, although no formal data are currently available, the TSDH approval of this segment for use as a domestic raw water supply indicates the acceptable quality of the waters. It is believed that the proposed TWQB monitoring program will further substantiate the acceptable quality of the water in this segment. There are no dischargers to this segment.

Recommendations.

Based on the preceding discussion of existing conditions in Segment 1425, it is recommended that the existing segment classification be changed to effluent limitation. It is also recommended that no changes to the Proposed Water Quality Standard be made.

TABLE VIII-24

PROPOSED EFFLUENT LIMITATIONS AND COMPLIANCE SCHEDULES FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)

1977 OBJECTIVE

SEGMENT NO. 1425

SEGMENT DESCRIPTION: San Angelo Reservoir

SEGMENT CLASSIFICATION: Water Quality Segment

MUNICIPAL FACILITIES

		Existing Permit Conditions				Proposed NPDES Permit: Permit Conditions						Proposed NPDES Permit: Compliance Schedule	Construction				
Name	WCO No.	Flow MGD	BOD mg/l	SS mg/l	Other	Flow MGD	BOD mg/l	SS mg/l	BOD kg/day	SS kg/day	Other	Permit	Start	Type	Period Yrs.	Basin Priority	Estimated Capital Cost
San Angelo Center Texas Department of Mental Health and Mental Retardation	10634-01	0.250 No Dis.	20			0.25 No Dis.						1-74					0

IX. LEGISLATIVE, JURISDICTIONAL, AND INSTITUTIONAL ARRANGEMENTS

General.

Legislative, jurisdictional, and institutional arrangements define the political environment within which an action may take place. The definition of this environment is essential in order to determine the political constraints which may effect a planning effort. This is particularly true in the development of a Basinwide water quality management plan. As summarized in Section 2 and detailed in Volume 4, there is a maze of agencies, ranging from local to Federal, which have some input into water-related matters.

In conjunction with this planning effort, attempts were made to define the political environment in relation to the development and implementation of a water quality management program in the Colorado River Basin. The results of this endeavor are summarized as follows:

Under Section 303 (e) of PL 92-500, the State is required to develop a continuing planning process which delineates the procedures that will be employed by the State to meet the objectives of the Law. The development of Basin control (water quality management) plans is an integral part of the process. The Environmental Protection Agency is the Federal agency which reviews and monitors the continuing planning process, as well as serving as the Federal agency with primary responsibility of implementing PL 92-500.

There are several State agencies associated either directly or indirectly with water quality within the State. The Texas Water Quality Board is the principal State authority on matters relating to water quality. Further, the Board is the State agency responsible for the development and implementation of the continuing planning process mentioned above.

There are numerous special districts within the Basin which have a direct involvement in water quality management. These districts vary from the river authority and water district which cover sizable areas and influence water quality in large portions of the Basin to the small municipal utility district which provides water utilities to a limited area.

The basic level of political interest is the community, which is the entity which must expend the capital investment to construct the wastewater collection and treatment facilities. The municipality is responsible for operating and maintaining the facilities in accordance with both Federal and State guidelines.

A detailed discussion of the political environment is contained in Volume 4 of the Colorado River Basin Wastewater Management Plan.

There are and will be political constraints which can affect the effective implementation of the proposed water quality management strategy for the Basin as presented in Section VIII. Several alternative implementation arrangements were evaluated to determine which arrangement could provide the most immediate effective implementation of the strategy. The five alternatives evaluated were as follows:

Alternative 1. (Current arrangement) The Texas Water Quality Board coordinates the implementation functions directly with individual municipalities and other public entities with provisions for Regional Implementing Authorities at such time as such regional systems are feasible.

Alternative 2. A compact composed of the Lower, Central and Upper Colorado River Authorities and the Colorado River Municipal Water District implements the wastewater management plan for the entire Basin.

Alternative 3. One of the existing River Authorities implements the plan for the entire Basin.

Alternative 4. A compact composed of the two major water districts in the Basin, the Lower Colorado River Authority and the Colorado River Municipal Water District, implements the wastewater management plan within the Basin.

Alternative 5. The regional council serves as the implementing agency for that portion of Basin within its jurisdictional boundary with the Texas Water Quality Board coordinating the overall implementation of the water quality management plan throughout the Basin.

TABLE IX - 1

IMPACTS OF IMPLEMENTATION ALTERNATIVES

ALTERNATIVE 1	2	3	4	5	FAVORABLE IMPACTS
X	X	X	X	X	Improvement of water quality in the basin.
X					Little disruption in existing institutional structure.
X					Utilization of existing local wastewater management staffs.
X					Local autonomy is maintained.
X					Utilization of special implementing authority for regionalization.
X	X	X	X	X	Possible realization of economics of scale through regionalization.
	X	X	X		Financial capabilities would be superior to those of the majority of individual municipalities and public entities.
	X	X	X	X	Regional unity of control for wastewater management in the basin.
	X	X	X	X	Possible equalization between the economic have and have not areas.
					UNFAVORABLE IMPACTS
X	X	X	X	X	Possible increase in local taxes and/or sewer rates.
X					Possible inefficiencies in water quality management in the basin.
X				X	Possible difficulties in obtaining financing.
	X	X	X		Would require an extension of the jurisdictional boundaries of the special district(s).
	X	X	X		Would require a mutual agreement between the four special districts.
	X	X	X	X	Legislative changes to existing institutional structures would be required.
	X	X	X	X	Takeover or replacement of already financed existing facilities may pose difficulties.
	X	X	X	X	Acceptance would be difficult to attain due to diversified political and public sentiments.
	X	X	X	X	Additional costs due to increased manpower requirements to implement plan.
	X	X	X	X	Erosion of local control of wastewater management decisions.
		X	X		Possible realization of impracticability of implementation control due to the tremendous size of the basin.
		X	X		Would require a complete revision of the present tax system.
				X	Voluntary nature of COG membership may make it difficult to obtain the consent of all member governments.
				X	Would require resolution of the legal question of COG's authority to implement plan.
				X	Possible administrative difficulties since COG's jurisdictional area is not totally within the basin.

The comparison of the alternatives involved an in-depth review of both the favorable and unfavorable impacts associated with implementation of the plan by the respective alternative. These specific impacts are summarized in Table IX-1. The following observations were made:

Water quality requirements of PL 92-500, as well as the State of Texas' requirements, would be met by all the alternatives.

All the alternatives provide means of meeting Federal and State Requirements for funding management. Alternative 1 would retain local autonomy to a higher degree than the other alternatives.

All of the alternatives provide sources of funding for treatment systems. Alternative 2 would probably provide superior financing capability because of the fiscal soundness of the river authorities in the Basin.

Legislation changes would be required to implement Alternatives 2, 3, 4, and 5. Past legislative efforts to alter district boundaries have met with concerted opposition and have consistently failed. It appears that the sentiments of the people within the Basin are such that such changes would still receive major opposition. Alternative 1 would not require legislative changes.

Alternative 1 would not require organizational changes. The other four alternatives would require changes in institutional arrangements.

Upon completion of the comparison of the five alternatives considered, continuation of the current implementation arrangement (Alternative 1) would afford the most effective immediate implementation of the water quality management strategy within the Basin. As cited in Volume 4, this arrangement provides central direction and control through the Texas Water Quality Board while at the same time assuring representation to the local municipalities served. It also offers flexibility in handling specific problems on an individual basis.

The detailed findings of the evaluation of the legislative, jurisdictional, and institutional arrangements--both present and future--within the Basin are presented in Volume 4, entitled "Institutional Arrangements."

X. IMPLEMENTATION OF STRATEGY

Implementation and Updating Responsibility.

Within the State of Texas, the agency or designated representative which holds responsibility for implementation and updating of Water Quality Management Plans is the Texas Water Quality Board (TWQB). The State Continuing Planning Process was developed to satisfy the requirements of Section 303 (e) of PL 92-500. The Process will, in general, (1) provide for preparation of water quality management plans for all waters within the State; (2) establish phasing of plans to be developed during the period from June 1973 through June 1975; (3) provide a method of coordination of the State's Water Quality Management Plan with related State or local comprehensive plans or programs, including land uses and natural resources planning activities; (4) provide for coordination with neighboring states for planning concerning interstate streams; and (5) provide for the expansion of the existing water quality management program.

The TWQB will function as the Agency with sole responsibility for updating the Colorado River Basin Wastewater Management Study on an annual basis as a minimum. Implementation of the proposals contained herein is also the overall responsibility of the TWQB. It is the immediate responsibility of local governments to implement such construction needs as will bring them into compliance with the Water Quality Act Amendments. It is the TWQB which has final responsibility for the quality of the water resource. This present implementation arrangement has been compared to other alternative arrangements in Volume 4 of this report and found to be the most effective immediate means to implement the Plan.

Manpower Requirements.

The status of operation and maintenance found throughout this study was characteristic of national trends in wastewater management. On a local level, wastewater operation continues to be a low-priority item among municipal needs. If any construction program is to result in a strategy of water quality management, this emphasis must be changed. Not all facilities in the Basin, due to their small size or method of treatment, would require full-time operator attention. It is recommended that the level of operation detailed in the Texas Water Utilities Association *Manual of Wastewater Operations* be utilized as a guide in the minimum specification of operation requirements for secondary treatment facilities. Those requirements are summarized briefly below:

Plant (mgd) Size	Personnel Requirements
0-0.25	One operator. During the normal five-day work week much of the operator's time will be required for routine operation of the treatment works and equipment maintenance. On Saturdays, Sundays, and holidays, one to two hours will be required for sludge pumping, equipment inspection, and minimum operational attendance. About eight hours per week will be required for sampling, for performing the listed tests, and for keeping the necessary records. For activated sludge plants, this time will be about 10 hours.
0.50	One full-time operator and one half-time laborer. With activated sludge plants, the laborer should also be full-time. About 10 hours a week will be required for the testing and record keeping; for activated sludge plants this time will increase to about 12 hours per week.
1.0	Two operators, one laborer, and about six hours per week of administrative supervision. For trickling filter plants, sampling, testing, and record keeping will require about 16 man-hours per week. For activated sludge plants, this time will increase to 20 to 22 man-hours per week.
5.0	One superintendent, four operators, one maintenance man, and one laborer to provide 24-hour attendance. About 40 hours a week will be required for the testing and record keeping. An activated sludge plant of this size will probably require a chemist and an additional laborer.
10.0	One superintendent, one chemist, six operators, one maintenance man, and two laborers to provide around-the-clock attendance.

In addition to these requirements, and as a level of support necessary to operate the irrigation operations proposed herein for final effluent disposal, it is recommended the following additional personnel requirements be considered.

Irrigation Tract Size (Acres)	Additional Field Personnel Requirement
0-100	1
100-200	2
200-400	3
400-600	4
600-	One per each additional 200 ac.

At the present time, insufficient conventional tertiary treatment facilities are in operation throughout the nation to develop confident estimates of the manpower requirements associated with various increments of tertiary treatment or various combinations of tertiary treatment processes. It can be estimated that implementation of full tertiary treatment to include nitrification, denitrification, phosphorus reduction, and filtration would double the manpower recommendations detailed above for secondary treatment.

Proposed Monitoring Program for the Colorado River Basin.

Introduction.

The TWQB maintains a Statewide network of in-stream sampling stations designed to effectively monitor the quality of the waters of the State. Each station has been designated as a chemical, biological, sediment, or pesticide sampling station--or any combination thereof.

All chemical stations will provide the following minimum parametric coverage and sampling frequencies:

1. Dissolved oxygen, temperature, pH, turbidity, and conductivity-monthly.

2. Chlorides, sulphates, and total dissolved solids (calculated from conductivity) - quarterly.

3. Fecal coliform - quarterly.

4. Total phosphate, ortho-phosphate. ammonia nitrogen, nitrate nitrogen, chlorophyll "a ", BOD_5, total suspended solids, and volatile suspended solids - quarterly.

5. Streamflow - at time of monthly sampling (USGS flow data will be utilized where available).

All biological sampling stations will monitor benthic macroinvertebrate communities quarterly. In addition, the following groups of organisms will be incorporated into the biological monitoring program before January 1, 1977:

1. Plankton
2. Periphyton
3. Macrophyton
4. Fish
5. Shellfish

Tissue analyses for chlorinated hydrocarbons and metals in inland waters are routinely performed semi-annually by the Texas Parks and Wildlife Department in cooperation with the U.S. Bureau of Sport Fisheries & Wildlife.

All sediment stations will measure the following parameters biannually:

1. Arsenic
2. Barium
3. Boron
4. Cadmium
5. Copper
6. Chromium (total)
7. Lead
8. Manganese
9. Mercury
10. Nickel
11. Selenium
12. Silver
13. Zinc
14. Insecticides
15. Herbicides
16. Total phosphate
17. Chemical oxygen demand
18. Kjeldahl nitrogen
19. Volatile solids
20. Oil and grease

Pesticide sampling stations will provide annual analyses of the following parameters:

<u>In Water</u>

Herbicides	Insecticides
2, 4-D	Heptachlor
2, 4, 5-T	Heptachlor epoxide
Silvex	Lindane
Diuron	Malathion
	Methoxychlor
	Parathion

In Sediment

Herbicide	Insecticide
Silvex	Aldrin
Diuron	Chlordane
	Chlorthion
	DDD
	DDE
	DDT
	Diazinon
	Dieldrin
	Endrin
	EPN
	Heptachlor epoxide
	Lindane
	Methoxychlor
	Methyl parathion
	Toxaphene
	Pb arsenate

Pesticide stations will also provide analysis for polychlorinated biphenyl compounds (PCB) in both water and sediment. In addition to the in-stream sampling conducted by the TWQB, the Agency has established an effluent monitoring system for all point source discharges. It is the intent of the Board to monitor all major dischargers on a quarterly basis. Manpower restrictions dictate that minor dischargers be monitored on a semi-annual or annual basis. Effluent sampling will provide analysis of all parameters specified in an individual's waste control order and any additional parameters which, in the judgment of agency field personnel, are necessary.

As a supplement to the effluent monitoring carried on by the TWQB, the agency has established a self-reporting system which requires all dischargers to monitor their own effluent on a regular basis. Municipal waste dischargers are required to report BOD_5, total suspended solids, chlorine residual, and flow three times each month. Industrial dischargers report BOD_5, COD, volatile suspended solids, total suspended solids, temperature, pH, and flow on a monthly basis.

Intensive monitoring surveys for water quality limited segments began in August 1973 and will be completed by December 31, 1973. The following is a list of the data that is proposed to be collected for the intensive surface water monitoring surveys:

Water Quality Data

Field Measurements

Diurnal temperature, dissolved oxygen, pH, conductivity, and alkalinity

Lab Analyses (On composite samples)

Conductivity (for TDS)
Nitrogen Series (K-N, NH_3-N, NO_2-N, NO_3-N)
Phosphate Series (total and ortho)
Sulfates and Chlorides
BOD_5
Suspended Solids (total and volatile)
Toxic Compounds (as appropriate)
Sediments (grab samples)

Hydrological Data

Flow (Q)
Time-of-Travel (as appropriate)
Stream Cross-sections (as appropriate)

Biological Data

Bacteriological
Benthic Macroinvertebrates
Phytoplankton and/or Periphyton (as appropriate)
Primary Productivity (upstream-downstream method)
Macrophyton
Algae Growth Potential

In addition to data obtained from the network of TWQB sampling stations, supplemental data from the programs established by USGS and the Texas State Department of Health (TSDH), as outlined in Section IV of this volume, will be available for verification of TWQB data. When TWQB data are found to be in conflict with USGS data, additional monitoring surveys will be required to identify problem sources of pollutants and/or to resolve discrepancies. If problem sources are identified, remedial action will be taken to bring the stream into compliance with water quality standards. It may be noted that USGS data will be printed concurrently with monthly TWQB data.

Segment Monitoring Programs.

The Colorado River Basin is an area of 39,893 square miles stretching 540 miles from the New Mexico border to the Gulf of Mexico. The Basin includes all or a portion of 62 counties in the State and encompasses segments 1401 through 1425 as designated in the Water Quality Standards prepared by the TWQB and forwarded to the EPA for approval on April 18, 1973.

Segment 1401.

Segment 1401 is the tidal segment extending from the mouth of the river at the Gulf of Mexico to the turning basin at river mile 22.8. One field analysis in 1972 produced a pH reading of 8.6 as opposed to the standard of 8.5, resulting in the segment being classified as water quality limited. However, this classification was undoubtedly premature, in that laboratory analysis taken the same day of the same sample revealed a pH of 7.5. No waste load allocations are considered necessary for the segment.

Segment 1401 receives industrial wastewater from the Celanese Chemical Company. The waters of the segment are deemed suitable for contact and non-contact recreation, and propagation of fish and wildlife.

The segment will be monitored by chemical, biological, and sediment station number 1401.01 located at FM 521 north of Matagorda.

Segment 1402.

Segment 1402 consists of the Colorado River above the tidal region to Tom Miller Dam. Like segment 1401, the segment was found by field analysis to be in violation of the pH standard by 0.1 pH unit.

These data were not verified by laboratory analysis, and no waste load allocations are necessary for the segment.

The segment receives domestic waste from the cities of Austin (three outfalls), Columbus, Elgin, Manor, Bastrop, Giddings, Weimar, La Grange, and Fayetteville; and from Development Associates, Inc., Colorado County WCID No. 2, Ellinger Sewer and Water Supply, Country Air, Inc., and Scenic Brook West, Inc. There are no industrial dischargers. Segment 1402 is deemed suitable for contact and non-contact recreation, propagation of fish and wildlife, and domestic raw water supply.

Due to the length of the segment, nine sampling stations have been established to monitor water quality. Station 1402.01 is a chemical and pesticide sampling station at US Hwy. 59 at Wharton. Station 1402.02 located at FM 950 at Garwood is a chemical, biological, sediment, and pesticide station. Stations 1402.03, 1402.04, and 1402.05 are chemical sampling stations located along SH 71 at Columbus, La Grange, and Smithville respectively. Station 1402.06 is located in Bastrop City Park one-half mile upstream from SH 71. The station will monitor chemical and biological parameters. Chemical and sediment station number 1402.07 is located at FM 973 at Del Valley. Two chemical sampling stations will monitor Town Lake. Station 1402.08 is located at Longhorn Dam, while 1402.09 is at the Town Lake headwater.

Segments 1402 to 1408.

Segments 1402 through 1408 comprise the area of the Colorado River known as the Highland Lakes. The waters of these lakes have long been known as being of excellent quality. However, with the exception of segment 1405 which is Lake Marble Falls, the lakes were classified as water quality limited due to the lack of data. Reclassification to effluent limited status is recommended for all the lakes. No waste load allocation will be made. The Highland Lakes are deemed suitable for contact and non-contact recreation, propagation of fish and wildlife, and domestic raw water supply.

Segment 1403 is defined as Lake Austin. There are no known point source discharges into the segment. Three chemical sampling stations will provide data. These are stations 1403.01 near Tom Miller Dam, 1403.02 near Metropolitan Park, and 1403.03 near the headwater at Lakeland Park.

Lake Travis has been designated as segment 1404. Lakeway MUD No. 1 is located on the lake, but the effluent is used for irrigation. The lake will be monitored by six chemical stations. The stations are 1404.01 near Mansfield Dam at the LCRA Travis County Park, 1404.02 at the Big Sandy Creek Arm, 1404.03 near Lakeway, 1404.04 at the Pedernales River Arm, 1404.05 above the confluence of the Pedernales River, and 1404.06 near Spicewood.

Segment 1405 consists of Lake Marble Falls, The segment will be monitored by two chemical sampling stations. Station 1405.01 is near Max Starcke Dam, while station 1405.02 is near US 281.

Lake Lyndon B. Johnson is designated segment 1406. There are no known point source dischargers into the Lake. Three chemical sampling stations will provide water quality data. Station 1406.01 is near Alvin Wirtz Dam, 1406.02 is near Sherwood Shores, and 1406.03 is near Kingsland at the lake's headwater.

Segment 1407 consists of Inks Lake. There are no known point source dischargers into the segment. Chemical stations 1407.01 near Inks Dam, 1407.02 at the Clear Creek Arm, and 1407.03 at SH 29 at the headwater will provide water quality data.

Lake Buchanan consists of segment 1408. The lake has no known point source discharges. Water quality data will be provided by chemical sampling stations 1408.01 near Buchanan Dam, 1408.02 at the Morgan Creek Arm, and 1408.03 near the lake's headwater.

Segment 1409.

Segment 1409 consists of Colorado River from the Lake Buchanan headwater to its confluence with the San Saba River. The segment has been classified as effluent limited on the basis of compliance with all applicable stream standards. No point source discharges are known. Chemical, pesticide, and biological sampling station 1409.01 at US Hwy. 190 east of San Saba will monitor the segment.

Segment 1410.

Segment 1410 consists of the Colorado River from the San Saba River confluence to the E. V. Spence Reservoir (Robert Lee Dam). The segment has been classified as water quality limited, based on a yearly average total dissolved solids of 1500 mg/l which was measured south of Bronte. The standard for the segment is 1250 mg/l.

The cities of Ballinger, Bangs, Santa Anna, and Winters contribute a calculated TDS load of 1,463 lbs/day on the segment, which is more than twice the segment target load of 673.8 lbs/day. However, all the plants discharge below the monitoring station which recorded the TDS violation, and the average TDS concentration actually decreases 500 mg/l in that reach of the segment within which the discharges occur. In addition, the flow in the upper portion of the segment is largely regulated by Robert Lee Dam. A review of water quality in E. V. Spence Reservoir revealed an average TDS of only 557 mg/l.

Segment 1410 will be monitored by two chemical and biological sampling stations. Station 1410.01 is located at SH 16 north of San Saba; station 1410.02 is at US Hwy. 83 in Ballinger.

Segment 1411.

Segment 1411 is designated as the E. V. Spence Reservoir. The segment is effluent limited and deemed suitable for contact and non-contact recreation, propagation of fish and wildlife, and domestic raw water supply. There are no known point source dischargers into the reservoir. Chemical sampling station 1411.01 located at the south end of Robert Lee Dam will monitor the segment.

Segment 1412.

Segment 1412 consists of the Colorado River from FM 2059 near Silver to Lake J. B. Thomas. Lack of data dictated the segment be classified water quality limited. The segment receives domestic waste from the cities of Big Spring, Colorado City, Loraine, and Snyder. Midland and Odessa are located within this segment. There are no known industrial dischargers on the segment. Water quality is deemed suitable for non-contact recreation and propagation of fish and wildlife. Segment 1412 will be monitored by chemical sampling station 1412.01 at FM 2059 near Silver and chemical-pesticide sampling station 1412.02 at SH 350 southwest of Ira.

Segment 1413.

Lake J. B. Thomas has been designated as segment 1413. One field analysis during 1972 yielded a pH of 8.6 as opposed to the standard of 8.5. However, the field test was not verified by laboratory analysis, and effluent limited status for the segment is recommended.

There are no known point source discharges into Lake J. B. Thomas and the waters are suitable for contact and non-contact recreation, propagation of fish and wildlife, and domestic raw water supply. The segment will be monitored by chemical sampling station 1413.01 at the Big Spring pump station upstream from the Colorado River Dam and north of Vincent.

Segment 1414.

Segment 1414 consists of the Pedernales River. The segment is effluent limited. As in other effluent limited segments, the water is deemed suitable for all its designated uses.

The segment will be monitored by chemical-pesticide-biological sampling station 1414.01 at US Hwy. 281 northeast of Johnson City and chemical-biological station 1414.02 at US Hwy. 290 southeast of Fredericksburg.

Segment 1415.

Segment 1415 consists of the Llano River. The segment is effluent limited and receives domestic waste from the City of Llano. The water is deemed suitable for non-contact recreation, propagation of fish and wildlife, and domestic raw water supply.

The Llano River will be monitored by two chemical-biological sampling stations. Station 1415.01 is located at a country road 6.5 miles upstream from Kingsland. Station 1415.02 is located 0.4 mile downstream from SH 16 at Llano.

Segment 1416.

Segment 1416 consists of the San Saba River. Domestic waste is discharged by the cities of Menard and Brady. The segment is effluent limited and suitable for contact and non-contact recreation, propagation of fish and wildlife, and domestic raw water supply. Two chemical-biological sampling stations will monitor the segment. Station 1416.01 is at SH 16 north of San Saba. Station 1416.02 is at FM 2092, five miles downstream from Menard.

Segment 1417.

Segment 1417 is Pecan Bayou from the Colorado River confluence to Lake Brownwood. The segment was in violation of the dissolved oxygen standard of 5 mg/l on two occasions during 1972. However, during the 7-day 2-year low flow condition, the flow is primarily treated sewage effluent. The standards provide for a minimum DO concentration of 2.0 mg/l in effluent dominated streams. Nevertheless, the segment has been classified as water quality limited.

The City of Brownwood, the segment's only known point source discharge, exerts a carbonaceous demand of 366 lbs/day. Calculations indicate that there is no reserve stream assimilative capacity for discharge of carbonaceous oxygen-demanding materials.

Segment 1417 is suitable for non-contact recreation, propagation of fish and wildlife, and domestic raw water supply. The segment will be monitored by chemical-biological sampling station 1417.01 at FM 2126 southeast of Brownwood and chemical station 1417.02 at US Hwy. 377 in Brownwood.

Segments 1418 and 1419.

Lake Brownwood and Lake Coleman have been designated as segments 1418 and 1419, respectively. There are no known point source discharges into the segments and the waters are suitable for contact and non-contact recreation, propagation of fish and wildlife, and domestic raw water supply. Although both segments have been classified as water quality limited due to lack of data, it is recommended that the existing segment classification be changed to effluent limitation. Lake Brownwood will be monitored by two chemical sampling stations. Station 1418.01 is located at the dam, while station 1418.02 is at SH 279 north of Brownwood. Lake Coleman has one chemical sampling station (1419.01) located near the dam.

Segment 1420.

Segment 1420 consists of Pecan Bayou above Lake Brownwood. The segment receives domestic waste from the cities of Coleman and Clyde and has been classified as water quality limited due to lack of data. Known water uses include contact and non-contact recreation, and propagation of fish and wildlife. The segment will be monitored by chemical-biological sampling station 1420.01 at SH 279 south of Cross Cut.

Segment 1421.

Segment 1421 consists of the Concho River from the Colorado River confluence to the fork in San Angelo, the South Fork Concho River to Lake Nasworthy, and the North Fork Concho River to the San Angelo Reservoir Dam. The segment is effluent limited, receives no known point source discharges, and is suitable for non-contact recreation, propagation of fish and wildlife, and domestic raw water supply.

The segment will be monitored by three sampling stations. Station 1421.01 is a chemical-pesticide-biological station at US Hwy. 83 at Paint Rock. Station 1421.02 is a chemical-biological station at FM 1692 south of Miles. Station 1421.03 is a chemical-biological-pesticide station at FM 380 near Veribest.

Segment 1422.

Lake Nasworthy has been designated as segment 1422. The lake is effluent limited and has no known point source discharges. The water is suitable for contact and non-contact recreation and propagation of fish and wildlife. Chemical station 1422.01 at the bridge near the intake structure south of San Angelo will monitor the segment.

Segment 1423.

Segment 1423 consists of Twin Buttes Reservoir. There are no known point source discharges to the segment. Water quality is suitable for contact and non-contact recreation, propagation of fish and wildlife, and domestic raw water supply, although the segment is temporarily classified as water quality limited due to lack of data. The segment will be monitored by chemical station 1423.01 near the intake structure at the dam.

Segment 1424.

Segment 1424 consists of the South and Middle Concho Rivers above Twin Buttes. The segment is effluent limited, has no known point source discharges, and is suitable for contact and non-contact recreation, propagation of fish and wildlife, and domestic raw water supply. The segment will be monitored by two chemical-biological sampling stations. Station 1424.01 is located on the South Concho River at SH 277 at Christoval. Station 1424.02 is on the Middle Concho River 0.5 mile southwest of Tullos Ranch headquarters and northwest of Tankersley.

Segment 1425.

The San Angelo Reservoir has been designated segment 1425. The segment has no known point source discharges and is suitable for contact and non-contact recreation, propagation of fish and wildlife, and domestic raw water supply. Lack of adequate data dictated an initial

water quality limited classification. It is recommended that the classification be changed to effluent limitation. Chemical station 1425.01 near the dam off the access road will provide data for the segment.

Other Stations.

In addition to sampling stations located on discrete segments, the TWQB has established several additional chemical sampling stations to accurately define the quality of other waters in the Colorado River Basin. Station 1400.01 is located on Beals Creek at SH 63 east of Big Spring. This station will also test for biological and pesticide parameters. Station 1400.02 is on Beals Creek at the Old Abilene Highway 1 1/2 mile east of the San Angelo STP. Station 1400.03 is on Spring Creek at FM 2335 near Knickerbocker. Station 1400.05 is on Lake Colorado City at the dam, southwest of Colorado City. Station 1400.06 is on Elm Creek at the Ballinger City Park. Station 1400.07 is on the North Concho River at a country road 0.6 mile southwest of Carlsbad. Station 1400.08 is on Jim Red Creek at FM 585 north of Bangs.

Table X-I presents existing and proposed monitoring stations and their relation to existing dischargers. This table is a summary of data presented in Section IV in regard to existing monitoring programs of the TWQB and USGS, in Sections VI and VIII regarding dischargers and their locations, and in Section X regarding the proposed monitoring program of TWQB. The tabular presentation originates at the furthest upstream proposed TWQB monitoring station on the main stream. Tributary gaging stations are presented from the furthest upstream proposed TWQB monitoring station downstream to its confluence with the Colorado River.

TABLE X-1

EXISTING AND PROPOSED MONITORING STATIONS AND THEIR RELATION TO EXISTING DISCHARGERS

Monitoring Stations						
Proposed TWQB No.	Existing TWQB No.	USGS No.	Location on Colorado River	Colorado River Miles	Tributary River Miles	Discharger
1413.01	1405.27	8118000	Lake J. B. Thomas	837.0		
1412.02		8119500	SH 350 at Ira	826.3		
			Deep Creek	814.3		Snyder STP
	1403.14	8121000	Colorado City	796.3		
1400.05	1400.40	8123000	Lake Colorado City	786.4		
			Champion Creek (0.5 miles east FM 700)	780.8		Loraine STP
			Beals Creek (0.5 miles east of Big Springs STP)	769.8	67.0	Big Springs STP
1400.02			Beals Creek	769.8	66.6	
1400.01		8123800	Beals Creek (SH 163)	769.8	19.9	
1412.01	1403.32		FM 2059	747.8		
1411.01	1404.13	8123950	E. V. Spence Reservoir	718.5		
		8124000	SH 208	712.4		
1410.02	1403.12	8126500	U. S. Hwy. 83	659.4		
			Elm Creek	658.9		Winters STP

TABLE X - 1 (Cont'd.)

Monitoring Stations						
Proposed TWQB No.	Existing TWQB No.	USGS No.	Location on Colorado River	Colorado River Miles	Tributary River Miles	Discharger
1400.06	1400.41		Elm Creek (Ballinger City Park)	658.9	.50	
			Elm Creek	658.9	.12	Ballinger STP
1400.07	1413.25	8134000	North Concho (Carlsbad)	628.9	22.9	
1425.01		8134500	San Angelo Reservoir North Concho	628.9	6.6	
1424.02	1412.24	8128400	Middle Concho	628.9	20.9	
1424.01	1411.23	8128000	South Concho (SH 277)	628.9	23.7	
1400.03	1400.30	8129300	Twin Buttes (Spring Creek)	628.9		
1400.04	1400.31	8130500	Twin Buttes (Dove Creek)	628.9		
1423.01		8131200	Twin Buttes Reservoir Middle Concho	628.9	4.0	
1422.01	1411.39	8132000	Lake Nasworthy South Concho	628.9	7.6	
1421.03	1410.38	8136150	Concho River (FM 380)	628.9	55.7	
			Concho River (Willow Creek)	628.9	40.8	Miles STP
1421.02			Concho River (FM 1692)	628.9	40.5	
1421.01	1410.21	8136500	Concho River (U.S. Hwy. 83)	628.9	19.6	

TABLE X-1 (Cont'd.)

Monitoring Stations						
Proposed TWQB No.	Existing TWQB No.	USGS No.	Location on Colorado River	Colorado River Miles	Tributary River Miles	Discharger
			Home Creek	566.6		Santa Anna STP
	1402.11	8138000	Winchell	560.7		
			Clear Creek	549.1		Bangs STP
			Pecan Bayou (Upper Region)	513.1		Clyde STP
			Pecan Bayou (Turkey Creek, 1 mile above SH 279)	513.1		Cross Plains
1420.01			Pecan Bayou (SH 279 at Cross Cut)	513.1		
1419.01			Lake Coleman	513.1		
			Lake Brownwood (Hords Creek)	513.1		Coleman STP
1400.08			Jim Ned Creek (FM 585)	513.1		
1418.02			Lake Brownwood (SH 279)	513.1		
1418.01		8143000	Lake Brownwood Dam	513.1		
1417.02	1400.20		Pecan Bayou (U.S. Hwy. 377)	513.1		
			Pecan Bayou (Willis Creek)	513.1		Atchison, Topeka, and Santa Fe

TABLE X-1 (Cont'd.)

Monitoring Stations						
Proposed TWQB No.	Existing TWQB No.	USGS No.	Location on Colorado River	Colorado River Miles	Tributary River Miles	Discharger
			Pecan Bayou (Willis Creek about one mile above FM 2126)	513.1		Brownwood STP
1417.01	1400.42		Pecan Bayou (FM 2126)	513.1		
1410.01			SH 16	501.6		
			San Saba River	479.8	110.1	Menard STP
1416.02			San Saba River (FM 2092)	479.8	104.9	
			San Saba River (Brady Creek)	479.8	46.7	Brady (Main Plant)
1416.01	1409.18	8146000	San Saba River	479.8	16.6	
1409.01	1401.36	8147000	U. S. Hwy. 190	474.3		
1408.03			Lake Headwater			
1408.02			Morgan Creek Arm			
1408.01		8148000	Buchanan Dam	413.6		
1407.03			SH 29	412.3		
1407.02			Clear Creek, Clear Creek Arm			Southwestern Graphite Co.
1407.01			Inks Dam	409.4		
1406.03			Lake LBJ, Kingsland	400.5		

TABLE X-1 (Cont'd.)

Monitoring Stations						
Proposed TWQB No.	Existing TWQB No.	USGS No.	Location on Colorado River	Colorado River Miles	Tributary River Miles	Discharger
			Llano River	400.3	110.6	Junction
			Llano River (Comanche Creek)	400.3	56.45	Mason STP
1415.02	1408.16	8151500	Llano River (SH 16)	400.3	24.19	
			Llano River	400.3	23.32	Llano STP
1415.01			Llano River	400.3	6.8	
1408.02			Lake LBJ, Sherwood Shores			
1406.01			Wirtz Dam	388.0		
1405.02	1401.33		U. S. Hwy. 281	383.4		
				382.0		Marble Falls WC&ID No. 1
1405.01			Starke Dam	381.8		
			Hamilton Creek	378.9		Lone Star Industries
			Barrons Creek, Pedernales	354.6	85.1	Fredericksburg
1414.02			Pedernales	354.6	82.6	
1414.01	1407.15	8153500	Pedernales	354.6	48.22	
1404.04			Pedernales River Arm	354.6	0	

TABLE X - 1 (Cont'd.)

Monitoring Stations: Proposed TWQB No.	Monitoring Stations: Existing TWQB No.	Monitoring Stations: USGS No.	Location on Colorado River	Colorado River Miles	Tributary River Miles	Discharger
1404.03			Near Lakeway			
1404.02			Big Sandy Creek Arm	325.2		
1404.01		8154500	Lake Travis, Mansfield Dam	318.0		Lakeway MUD No. 1
1403.03			Lakeland Park			
1403.02			Metropolitan Park			
			Lake Austin			St. Stephens School
1403.01			Tom Miller Dam	297.6		
1402.09			Headwater Town Lake	297.0		
			Town Lake			Holly Street Power Plant
			Town Lake			Seaholm Power Plant
1402.08			Longhorn Dam	291.6		
				291.0		Capital Aggregates Inc.
	1401.7	8158000	U. S. Hwy. 183	290.3		
				288.0		Austin Govalle STP
			Boggy Creek	287.5		John Roberts, Inc.

TABLE X - 1 (Cont'd.)

Monitoring Stations						
Proposed TWQB No.	Existing TWQB No.	USGS No.	Location on Colorado River	Colorado River Miles	Tributary River Miles	Discharger
				286.7		Austin Walnut Creek STP
				283.0		Austin Hornsby Bend STP
1402.07			Del Valle FM 973	280.5		
			Onion Creek	275.5		Buda STP
			Onion Creek	275.5		Country Air STP
			Onion Creek	275.5		Scenic Brook West STP
			Gilleland Creek	271.7		Manor STP
			Dry Creek	261.7		Development Associates STP
			Big Sandy Creek	245.2		City of Elgin STP
1402.06	1401.34	8159200	Bastrop City Park	236.8		
				236.0		Bastrop STP
			Gazley Creek	212.15		Smithville STP
1402.05		8159500	Smithville SH 71	212.1		
			Rabbs Creek	186.3		City of Giddings STP
1402.04			LaGrange SH 71	176.0		

TABLE X - 1 (Cont'd.)

Monitoring Stations: Proposed TWQB No.	Existing TWQB No.	USGS No.	Location on Colorado River	Colorado River Miles	Tributary River Miles	Discharger
		8160500	U. S. Hwy. 77	174.5		
			Pettys Creek	159.0		Ellinger STP
			Harveys Creek	149.5		City of Weimar STP
1402.03			Columbus SH 71	141.4		
			Cummins Creek	137.5		Fayetteville STP
			Cummins Creek	137.5		Giddings State Boys School
				134.5		Columbus STP
		8161500	Near Eagle Lake	112.4		
				105.0		City of Eagle Lake STP
			Garwood	101.2		Gifford Hill & Co., Inc.
1402.02			Garwood FM 950	100.5		
1402.01	1401.3	8162000	Wharton U. S. Hwy. 59	66.6		Colorado County WCID No. 2
				65.8		Wharton STP
		8162500	Bay City	32.5		
				22.5		Celanese Chemical Co.
1401.01	1414.29		FM 521	15.9		

Water Rights Impacts and Constraints.

Special emphasis and attention will be given by all agencies and entities to water rights impacts and constraints throughout the processes of development, review, and coordination of detailed plans for wastewater treatment facilities, the operational plans thereof, and the Colorado River Basin Wastewater Management Plan. (See Volume 4 for a brief outline of the major relevant duties and responsibilities of the Texas Water Rights Commission.)

The following selected statutory rules, regulations, and guidelines are furnished regarding water rights impacts and constraints.(Citations of Sections refer to the Texas Water Code): [1]

1. Penalties. No person may willfully take, divert, or appropriate any State water for any purpose or begin construction of any work designed for the storage, taking, or diversion of water, without first obtaining a permit from the Commission to appropriate the water in accordance with these rules [Sections 5.081(a) and 5.121].

   a. A person who takes, diverts, or appropriates any State water without obtaining a permit is guilty of a misdemeanor and upon conviction is punishable by a fine of not more than $100 or by confinement in a county jail for not more than six months or by both [Section 5.081(b)].

   b. Without obtaining a permit, a person may construct on a nonnavigable stream on his own property a dam or reservoir to impound or contain not more than 200 acre-feet of water for domestic and livestock purposes (Section 5.140).

2. Purposes for Water Appropriation. The right to the use of State water may be acquired by appropriation in the manner herein provided and for the following purposes: domestic and municipal, industrial, irrigation, mining and recovery of minerals, hydroelectric power, navigation, recreation, stockraising, public parks, game preserves, and for other beneficial purposes. Unappropriated stormwater and floodwater may be appropriated to recharge underground fresh water bearing sands and aquifers in certain areas of the State, if it can be established by expert testimony that an unreasonable loss of State water will not occur and that the water can be withdrawn at a later time for application to a beneficial use (Section 5.023).

(1) The Rules referred to are those contained in the "Proposed Rules, Regulations and Modes of Procedure of the Texas Water Rights Commission, 1972 Revision, First Edition."

3. Priority in Appropriation of Water. In the allotment and appropriation of State water to uses beneficial to the public welfare, preference shall be given to the following uses in the order named:

   a. Domestic and municipal uses, including water for sustaining human life and the life of domestic animals;

   b. Industrial uses, being processes designed to convert materials of a lower order of value into forms having a greater usability and commercial value, including the development of power by means other than hydroelectric;

   c. Irrigation;

   d. Mining and recovery of minerals;

   e. Hydroelectric power;

   f. Navigation;

   g. Recreation and pleasure; and

   h. Other beneficial uses (Sections 5.024 and 5.122).

4. Multiple Purposes. A permit may be issued for multiple purposes. The amount of water authorized to be appropriated for each purpose shall be specifically appropriated for that purpose [Sections 5.023(e) and 5.134(5)]

5. Direct Diversion. A permit for direct diversion is required of all persons who propose to divert State water from a watercourse or its underflow, without storage, and apply it to its authorized use. The manner of diversion may be by pumping or by gravity flow.

6. Diversion. A permit for diversion is required of all persons who propose to divert water from a reservoir and apply it to an authorized use. The manner of diversion may be by pumping or by gravity flow. (Although a person may hold a valid permit for a reservoir or storage facility, water cannot be diverted and used from the reservoir unless the permit so authorizes.) (See Rule 205.7).

7. <u>On-Channel Reservoir</u>. A permit for an on-channel reservoir grants the right to construct a dam on a watercourse. Permission must be obtained to appropriate State water to fill the reservoir, divert and use the water, or use the water in place.

8. <u>Off-Channel Storage.</u> A permit for an off-channel reservoir grants the right to construct an impounding structure that will not be directly on a watercourse, and to fill the reservoir by means of direct diversion. Permission is required to appropriate State water to fill the reservoir and to divert and use water therefrom.

9. <u>Storage in Another's Reservoir</u>. A permit is required to appropriate State water for storage in another's lawful reservoir and to divert and use water therefrom. Consent of the reservoir owner must be obtained.

10. <u>Storage in Soil Conservation Service Reservoir.</u> If the reservoir is a project of the Soil Conservation Service, United States Department of Agriculture, consent must be obtained from the Soil Conservation District and any others having jurisdiction over the reservoir before a permit can be acquired.

11. <u>Multiple Ownership of Reservoir.</u> When a reservoir is owned by more than one person, an applicant for the use of the State waters impounded in the reservoir must obtain the consent of all owners of land inundated by the reservoir. In the alternative, the reservoir owners may join in the application for a permit. This requirement is in addition to Rule 210.6 where applicable.

12. <u>Source of Supply.</u> The applicant for a water use permit shall clearly state the name of the source from which it is proposed to divert water. This does not mean the origin of the water, but the stream, spring or body of water from which the proposed diversion will be made. If the source has no name, it may be designated as "an unnamed stream" or "an unnamed spring." If the source is a tributary, the next stream into which it flows and the river basin shall be listed in the space provided on the form [Section 5.123(3)].

13. Amount and Purpose of Use. The total amount of water to be used shall be stated in definite terms, i. e., a definite number of acre-feet annually, or in the case of a temporary permit application, over the period for which application is made. Also, the purpose or purposes of each use shall be stated in definite terms. If the water is to be used for more than one purpose, the specific amount to be used for each individual purpose shall be clearly set forth [Section 5. 123(4)]

14. Trans-Watershed Transfers. No person may transfer State water from one watershed to another without first obtaining a permit from the Commission [Section 5. 085(b)]. An applicant seeking to transfer State water from one watershed to another watershed shall so state in addition to the regular requirements. Procedures to be followed are governed by provisions of Section 5. 085.

15. Applicant Must Own Land. In the case of individuals, no application for water to irrigate land will be accepted for filing if the land to be irrigated is not owned by the applicant. The applicant may be required to offer proof at the public hearing on his application to substantiate his ownership. In the event that the applicant does not own the land, it will be necessary for such landowner or landowners to join in the application.

16. Use Other Than Domestic or Livestock. A person desiring to divert State water for other than domestic and livestock uses, from either a reservoir constructed by the Federal government for which no local sponsor has been designated and permit issued, or a reservoir permitted for storage solely for the purpose of optimum development of the project, shall make application to the Commission for a permit pursuant to Section 5. 123.

17. Domestic or Livestock Use. A person desiring permission to use State water for domestic and livestock uses from either a reservoir constructed by the Federal government for which no local sponsor has been designated and permit issued, or a reservoir permitted for storage solely for the purpose of optimum development of the project, shall apply to the Commission for authorization.

18. **Application for Permit Under Section 5.141, of the Texas Water Code.** Without obtaining a permit, a person may construct on a nonnavigable stream on his property a dam and reservoir to impound or contain not more than 200 acre-feet of State water for domestic and livestock uses. The owner of such a dam or reservoir who desires to use State water therefrom for purposes other than domestic and livestock use shall obtain a permit to do so (Sections 5.140 and 5.141). He may elect to proceed under the provisions of Section 5.123 and Rule 215 and its subsections.

19. **Reservoirs Without Low-Flow Outlets.** All permits granted under Rule 245 for uses other than recreation shall expire within a term of years not to exceed fifteen years unless the dam is equipped with a low flow outlet sufficient to pass flows as the Commission finds necessary to satisfy the rights of downstream domestic and livestock users and the senior and superior rights of other authorized users.

20. **Contractual Permit.** In order for the Commission to exercise effectively its right of continual supervision over all permits, purchasers of raw water shall make application for a permit based upon contractual arrangements with a supplier, provided that this requirement shall be applicable only to purchasers of stored State water whether diverted from the reservoir or released to be diverted at a specified downstream location and shall apply only to purchasers from a supplier having a valid right to the impounded waters. Unless otherwise provided, no permit will be granted hereunder unless provision is made for the adequate measuring of water sold and diverted. In the case of the release of stored State water for diversion downstream, no permit will be granted unless the agreement specifies which party shall bear transportation and evapotranspiration losses in the conveyance of water in the watercourse.

21. **Permit Subject to Prior Rights.** Every permit to appropriate State waters granted by the Commission shall be conditioned on its being subject to all prior existing rights of others using water on the stream or other source of supply.

22. **Optional Provisions of a Permit.** The Commission reserves the right to incorporate in every permit any condition, restriction, limitation or provision reasonably necessary for the enforcement and administration of the water laws of the State and the rules and regulations of the Commission.

23. **Implications of Accepting a Permit.** Acceptance of the permit by the permittee shall be an acknowledgement and agreement that the permittee will comply with all the terms, provisions, conditions, limitations, and restrictions embodied in such permit.

24. **Excess Diversions.** The use of water by the appropriator in excess of the amount authorized by the permit or certified filing shall not establish a right on the part of the appropriator to use excess water in the future. Neither shall the use of water for any purpose not authorized by a permit or certified filing establish a right to use water for unauthorized purposes.

25. **Return and Surplus Waters.** All return and surplus water shall be returned to a source of water supply or watercourse at the point or points stated in the permit or amendatory orders of the Commission. Return water shall conform to quality standards set by the State. The failure to discharge and return water shall cause the right to divert to lapse until the water right is reinstated by order of the Commission.

26. **Use of Bed and Banks to Convey Stored Water.** Anyone proposing to use the bed and banks of any flowing natural stream within this State for the purpose of conveying stored water from a place of permitted storage to a place of permitted use must first comply with the contract requirements of Section 5.042 and the rules and regulations of the Texas Water Rights Commission as set out in Rule 246. The requirements of this section may be waived by the Commission where an emergency condition exists and time does not permit following the procedures herein outlined. Further, the requirements of this section are not applicable where water is being released from upstream storage under order of the Texas Water Rights Commission.

27. **Duties of Others Along the Stream.** When stored waters are released from a reservoir or dam and are designated for use or storage downstream by a specified user legally entitled to receive the water, it shall be unlawful for any person without legal right to divert, store, appropriate, use, or otherwise interfere with the passage of the waters that are designated for downstream use or storage. Each owner or operator of a reservoir and dam on the stream between the point of release and the point of

designation shall permit the free passage through the reservoir and dam of all such released waters in transit.

For further details, attention is directed to the Rules, Regulations and Modes of Procedure of the Texas Water Rights Commission.

Financial Evaluation.

The national effort to meet the objectives of PL 92-500 will require an expenditure of perhaps unprecedented proportions. In a general period of fiscal nonavailability throughout the nation, some considerations and philosophies pertinent to the Colorado River Basin, to Texas, and to the country are worthy of discussion. In these considerations and allocations of tax revenues derived from the many, an atmosphere of fairness and just allocation must temper the technical and administrative objectives established by PL 92-500.

The first of these considerations is the value of prior-constructed facilities and what these facilities indicate in terms of local priorities antecedent to PL 92-500. Unlike many areas of the country, the State of Texas has sought as an early objective treatment of municipal wastewaters to a point beyond primary treatment. As a result, at the present time there are no known treatment facilities in the State that do not provide some form of biological secondary treatment. In the establishment of a goal of secondary treatment for the waters of Texas, a priority was set and expenditures made that could have been directed toward other municipal needs. It would not seem just that, in the allocation of tax revenues, the State or area which has attempted to accomplish the goal of secondary treatment should now not receive a proportionate share of available construction funds derived of the taxes from the many.

In light of the limited availability of construction funds, consideration may be given on the national level to regress on the scale of participation in wastewater works construction by the Federal government. With the passage of PL 92-500 it was the intent of the Congress to increase the level of Federal participation in wastewater treatment facilities to 75 percent. Promise of increased participation, together with a lack of available grant monies, has inadvertently resulted in a veritable freeze of construction activity. Municipalities which were prepared to go forward with facilities construction utilizing the prior rate of Federal participation have revised grant application requests to reflect the new participation.

In completion of this study effort, a construction needs list and a priority listing were developed to indicate the level on construction effort required to place the Basin in compliance with PL 92-500. The methodologies utilized in the development of these listings are presented in Section VIII of this report. A single treatment alternative for each facility was selected and presented with its associated capital expenditure estimate. The summation of the recommended alternative for all facilities results in the required levels of expenditure necessary to place the Colorado River Basin in compliance with PL 92-500. These estimated levels of treatment capital expenditure are as follows:

FUNDING LEVELS TO MEET WATER QUALITY OBJECTIVES.

Year:	1977 Objective	1983 Objective	No Discharge of Pollutants
Expenditure:	$26,031,000	$23,865,300	$8,034,300

It is anticipated that the local participation or repayment toward these goals will be as varied in nature as the entities supporting the construction. By local preference to seek the optimum interest rate or dependent on the prior level of indebtedness, facilities will be supported by either revenue or general obligation bonds. It has been observed that the larger the municipality, the more likely it is that the city has reached its level of general obligation bonded indebtedness and thus will be required to finance improvements through revenue bonds.

It is not within the scope of this study to enter in detail the method of repayment for each facility or the bonding capability of each municipality, but to indicate that the method of repayment which is primarily a local responsibility will continue to be highly variant.